Lighting

“Power and Analog” certification program

Luca Salati

Industrial and MultiMarket BU – EMEA region

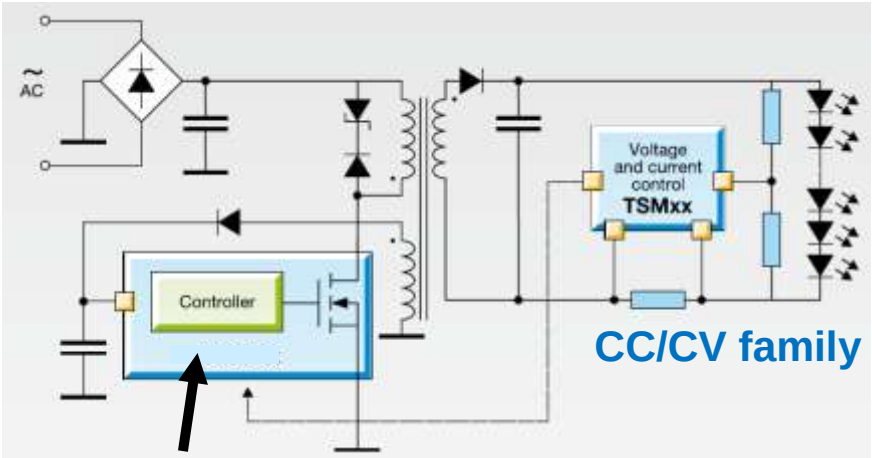
Agenda

- LED drivers for illumination
- LED drivers for arrays / displays and backlight
- Support tools

Illumination – low power

- Replacement of existing incandescent lamps (banned), up to 12-15W, connected to the Mains voltage
  - Few high-power LED (I_{LED}>350mA)
  - Several low-power LED (I_{LED}<100mA)

- Needs:
  - LED current regulation within a specified tolerance
  - (Sometimes) electrical isolation
  - Correction of power factor
  - Compatibility with standard dimmers



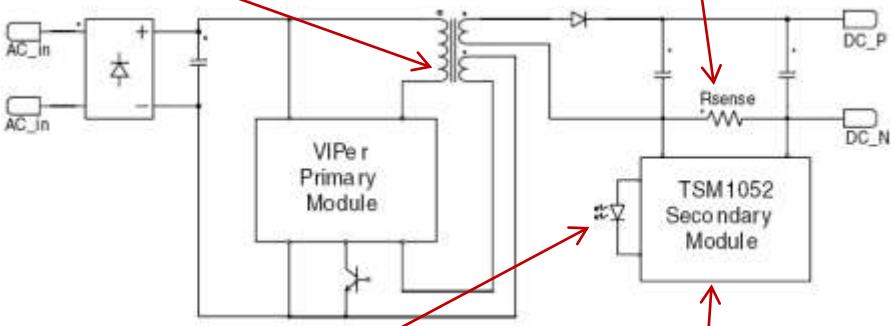
HVLED805 (no need of TSM) or Viper+ family

Improved BOM, Form Factor & Efficiency

Standard Isolated Solution with VIPer

Auxiliary winding :
- Vcc for Viper

Sense resistor in series with LEDs



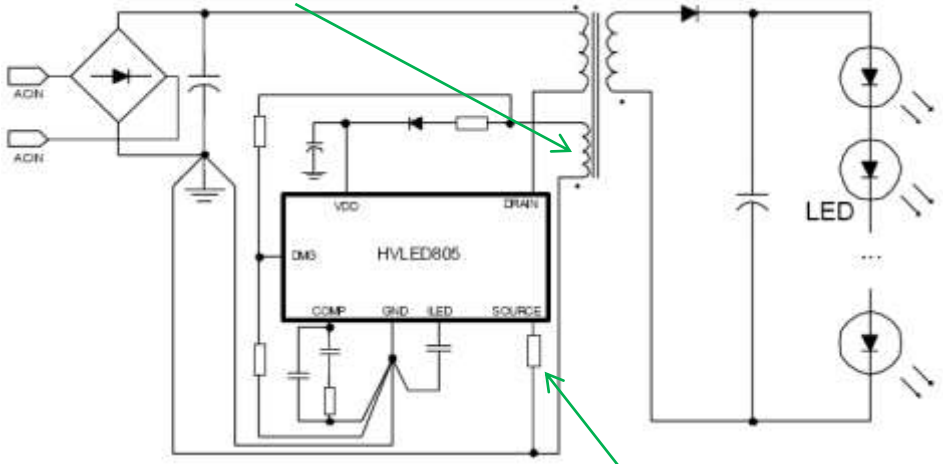
Opto-coupler for galvanic isolation

Constant Current Controller

- 2 ICs + 1 Opto
- $R_{sense}*I^2$ dissipation

Primary Side Regulation Solution with HVLED805

Auxiliary winding :
- Vcc for HVLED805
- Constant Current ctrl



LED current set by resistor

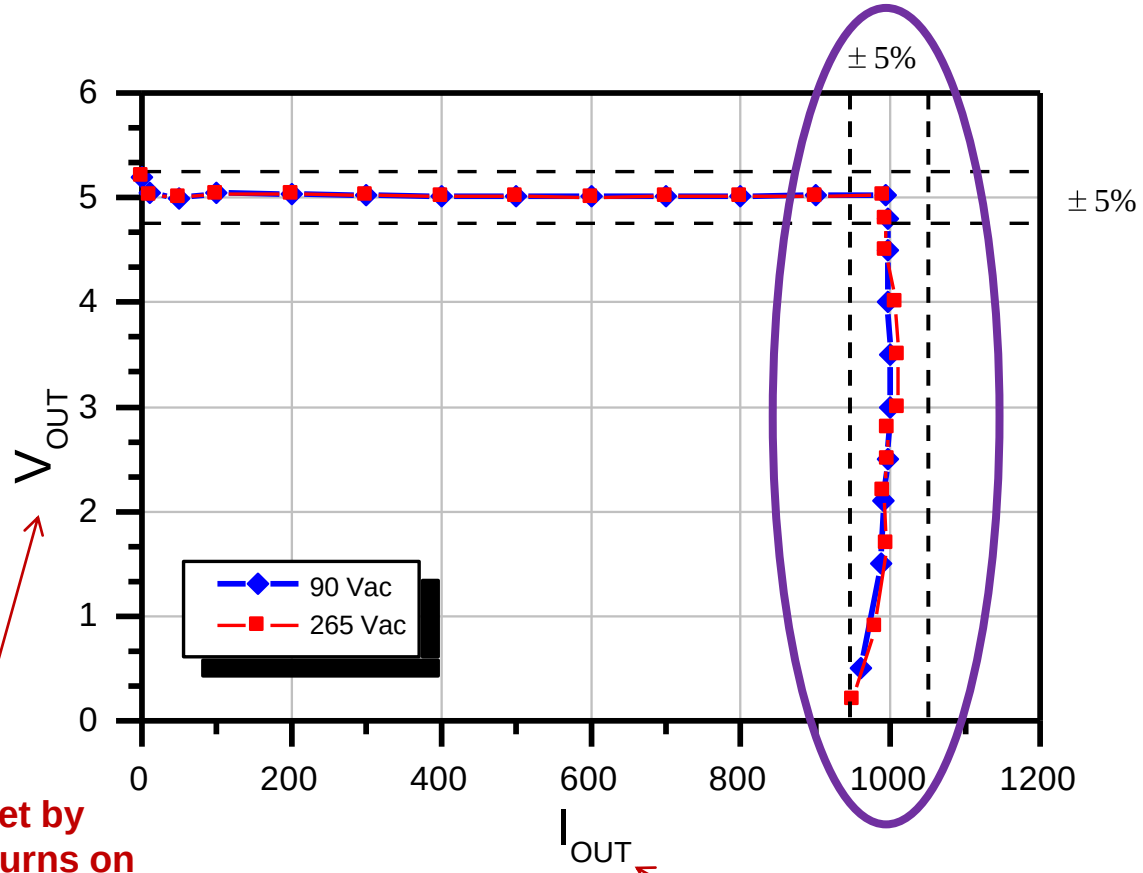
- Only one IC
- No secondary R_{sense} dissipation

HVLED805
FEATURES and BENEFITS

Up to 10W in EU input range

• Integrated MOSFET, No Opto, No CC controller.	➢ Compact and cost effective Solution
• Quasi-Resonant operation, no dissipation in Rsense (@ secondary)	➢ Improved efficiency, reliability and EMI
• 800V MOSFET with HV start-up	➢ Improved reliability, Smaller Snubber
• Burst Mode at low load & Transformer Saturation detection.	➢ Full safety against all LED Failure Modes (short & open)
• Primary Side Regulation allows +/- 5% output current accuracy. Feedforward compensation.	➢ LED current accuracy independent on Mains Voltage.

Constant Current (/ Constant Voltage)



The number of LEDs and their current determine the transformers' calculation.

Vout is set by number of turns on secondary and auxiliary windings, and Rfb

$$R_{FB} = \frac{V_{REF}}{\frac{n_{AUX}}{n_{SEC}} \cdot V_{OUT} - V_{REF}} \cdot R_{DMG}$$

Iout is set by transformer's ratio and Rsense

$$I_{OUT} = \frac{n}{2} \cdot \frac{V_{CLED}}{R_{SENSE}}$$

EVALHVLED805 - description

4.2 W off-line LED driver with primary side regulation

- Input voltage range (VIN): 185 - 265 VAC
- Main frequency (fL): 50 - 60 Hz
- Maximum (rated) output power: 4.2 W
- Output: IOUT = 350 mA ± 5%
  - Over voltage = 12 V max
  - Current ripple < 10% IOUT
- Minimum switching frequency in normal mode: 70 kHz
- Target average efficiency (from 1 to 3 LEDs) > 70 %

Documentation:

- **Databrief (board description) and product presentation at http://www.st.com/internet/analog/product/251116.jsp**

Key Product:

✓ HVLED805
✓ STTH1L06A
✓ STPS1H100A

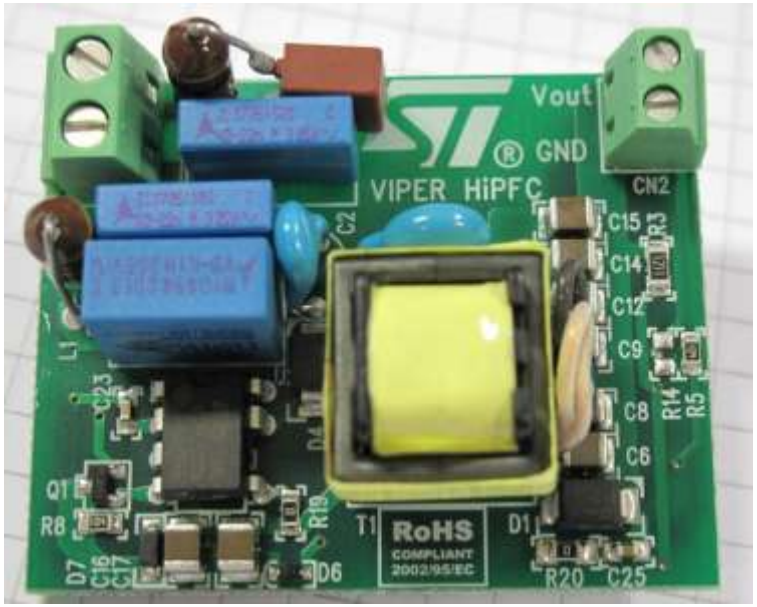
Typical Applications:

✓ AC-DC LED power supply (not dimmable)

Board Purpose:
Product evaluation

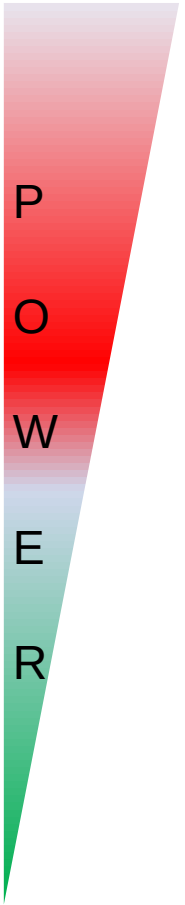
3 to 10 W Applications: VIPerPlus
High Voltage Converters in Flyback Topology

- Simple solution to get high Power Factor Correction (> 0.9)
- 3.5W (350mA) with VIPer17 and 7W (700mA) with VIPer27
- 90 - 265Vrms Input voltage range
- Open / Short circuit protection
- No High voltage electrolytic capacitors
- Optional low voltage electrolytic capacitor
- Efficiency higher than 80%



Illumination – medium/high power

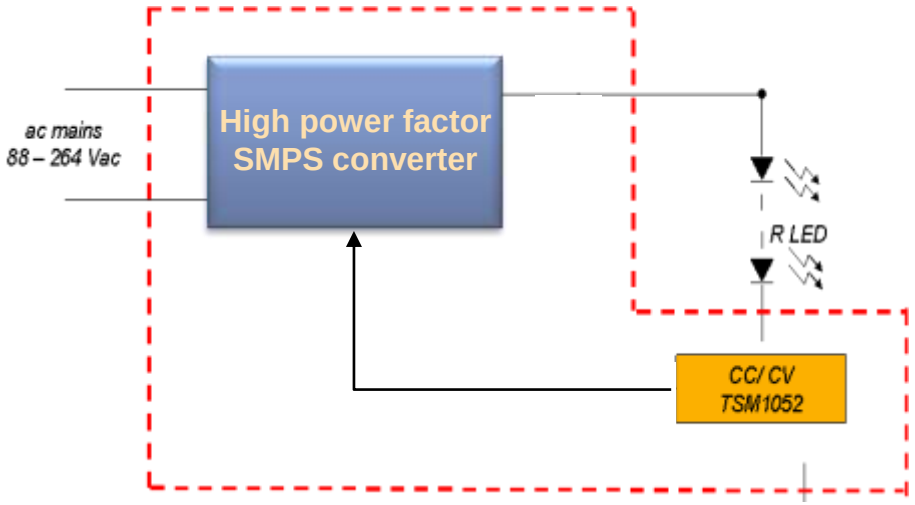
- Replacement of existing fluorescent/ HID lamps, up to 120-150W, connected to the Mains voltage
  - Outdoor illumination (streetlight)
  - Indoor illumination (offices, parking areas, decorative lighting…)
- Needs:
  - LED current regulation within a specified tolerance
  - Electrical isolation
  - Correction of power factor (mandatory above 25W)
  - White / RGGB LEDs
  - Analog (SMPS or linear) / Digital control
  - Analog / PWM dimming
  - Single/multi LED string configuration
  - Very fragmented segment → not easy to point-out the “UNIVERSAL SOLUTION”



Illumination – medium/high power

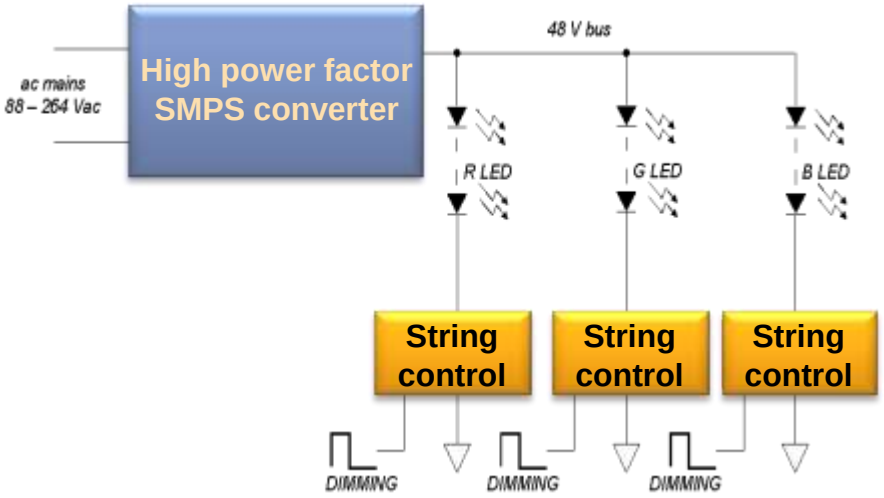
Single string:

- Current controlled SMPS
- LED string current control



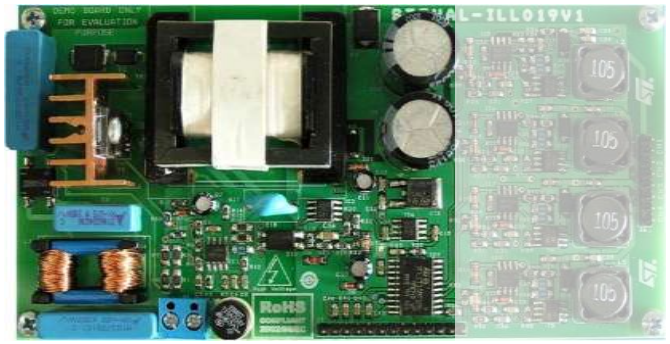
Multiple string:

- Voltage controlled SMPS
- independent LED string current control:
  - Linear
  - Analog switching
  - Digital switching



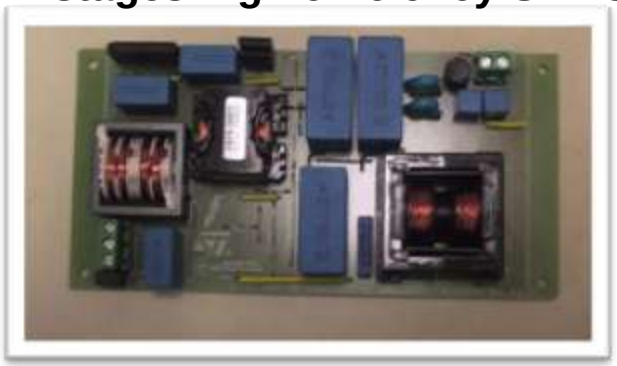
Illumination – medium/high power SMPS and CC/CV

High power factor flyback (< 50-60W)



- **L6562A / L6564 / L6563*** PF controller
- >600V mosfet (**SuperMesh NK/K3**)
- >100V secondary rectifier (**power Schottky / turbofast**)
- **Tx431** voltage reference

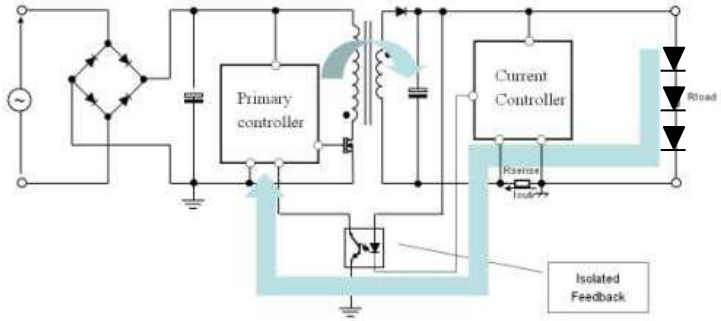
2-stages high efficiency SMPS (>50W)



No HV el-CAP

- **L6562A** (PF controller) + **L6599A** (resonant controller)
- 3 x “500/600V” mosfet (**SuperMesh NK/K3, MDMesh II**)
- 2 x “>100V” secondary rectifier (**power Schottky / turbofast**)
- 600 turbofast rectifier (**STTHx06**)
- **Tx431** voltage reference

CC / CV controller

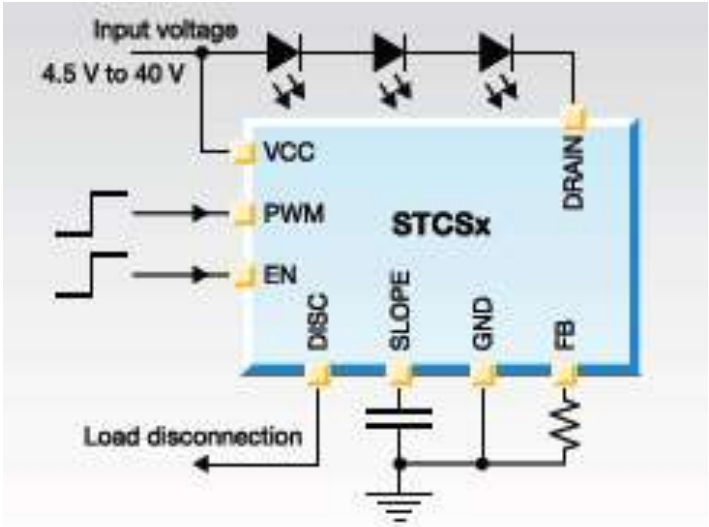


Commercial product	Voltage reference	Voltage reference precision	Vcc range	Icc typ	Package
TSM101/A	1.24 V	1%	4.5-32 V	< 2 mA	DIP8, SO8
TSM103W	2.5 V	0.4%, 0.7%	3-32 V	0.7 mA	SO8
TSM1011	2.545 V	0.5%, 1%	4.5-28 V	< 1 mA	SO8, TSSOP8
TSM1012	1.25 V	0.5%, 1%	4.5-28 V	100 uA	SO8, TSSOP8
TSM1013	2.545 V	0.5%, 1%	4.5-28 V	< 1 mA	SO8, TSSOP8
TSM1014	1.25 V	0.5%, 1%	4.5-28 V	100 uA	SO8, TSSOP8
TSM1052	1.21 V	1%	1.7-18 V	150 uA	SOT23-6L
SEA05	2.5V	+/- 0.5%	3.5-36V	200uA	SOT23-6L

Illumination – medium/high power LED string current control - linear

STCSx family

- Low cost solution
  - No chokes / low BOM
  - Less EMI generated
- Lower efficiency
  - Convenient when V_{LED} is close to V_{IN}
- Adjustable current (FB)
- Microcontroller compatible dimming input pin
- Load (LED) disconnection diagnostic



Part number	Description	IOUT (A)	VIN (V)	VOUT (V)	NLED (WHITE)	FSW (kHz)	Package	Extra functions
STCS05	0.5 A max constant-current LED driver	0.5	4.5 to 40	Vin- V_DROP	9	-	SO8	Dimming, Diagnostic, EN
STCS05A	0.5 A max constant current LED driver	0.5	4.5 to 40	Vin- V_DROP	9	-	SO8	Dimming, Diagnostic, EN
STCS1	1.5 A max constant-current LED driver	1.5	4.5 to 40	Vin- V_DROP	9	-	DFN3x3-8L/HSOP8	Dimming, Diagnostic, EN
STCS1A	1.5 A max constant-current LED driver	1.5	4.5 to 40	Vin- V_DROP	9	-	DFN3x3-8L/HSOP8	Dimming, Diagnostic, EN
STCS2	2 A max constant-current LED driver	2	4.5 to 40	Vin- V_DROP	9	-	PowerSO-10	Dimming, Diagnostic, EN
STCS2A	2 A max constant-current LED driver	2	4.5 to 40	Vin- V_DROP	9	-	PowerSO-10	Dimming, Diagnostic, EN

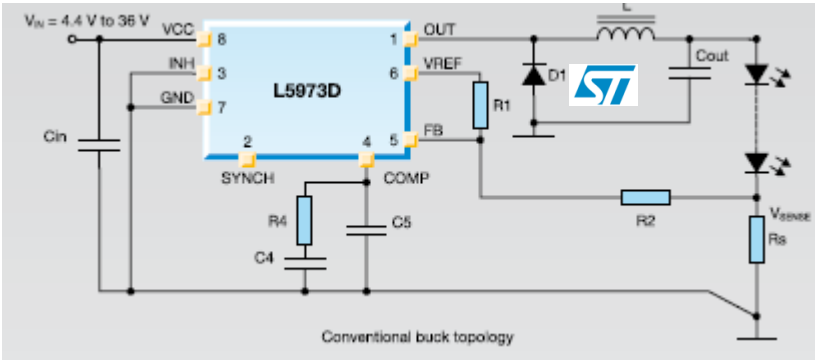
Illumination – medium/high power LED string current control - SMPS

STEP-DOWN monolithic (= current limited, small area)

Example: up to $36V_{DC}$ – L597x family
(suitable also for inverting / positive buck-boost)

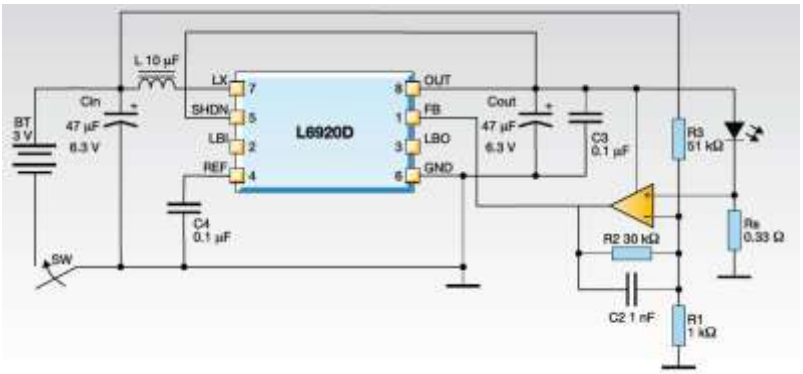
Same approach with:

- **L497x**: Vin up to $63V_{DC}$
- **ST1Sxx**: Vin up to $48V_{DC}$
- **L6902:** Vin up to $36V_{DC}$
- **L798x**: Vin up to $28V_{DC}$
- **L598x and ST1CC40**: Vin up to $18V_{DC}$



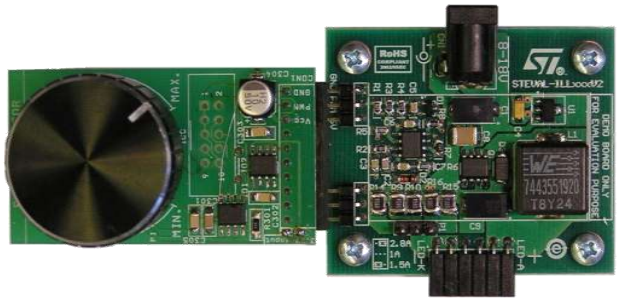
STEP-UP

- **ST8R00:** Vout till $12V_{DC}$
- **L6920:** Vout up to $5.2V_{DC}$

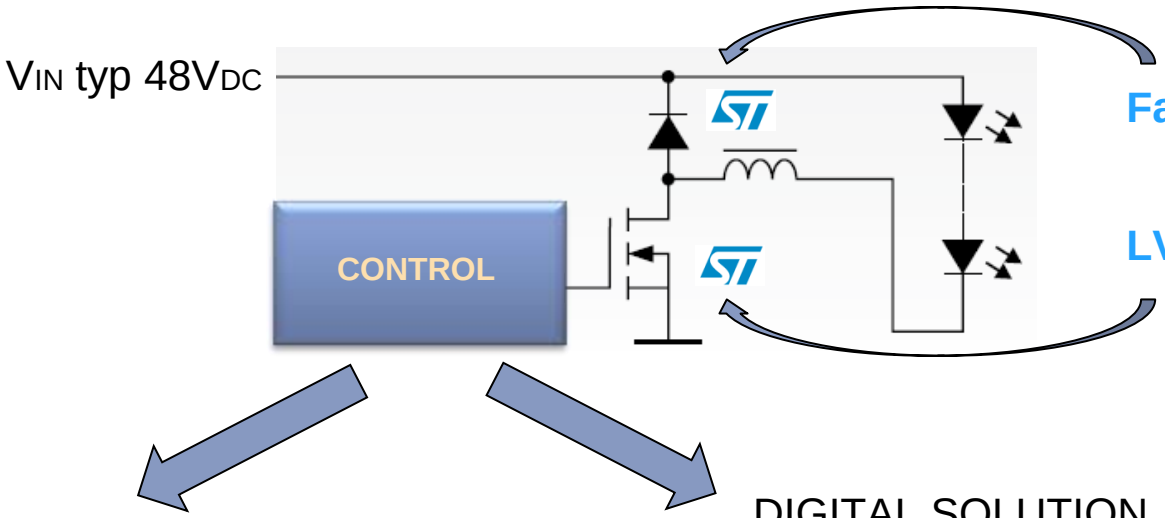


STEP-DOWN controller (=flexible solution for higher current)

- **L6727** DC-DC controller
- **2 x STS8DNH3LL** mosfet (upgrade for higher current)
- **STPS1L30M** free-wheeling diode (upgrade for higher current)



Illumination – medium/high power
LED string current control – analog/digital modified buck

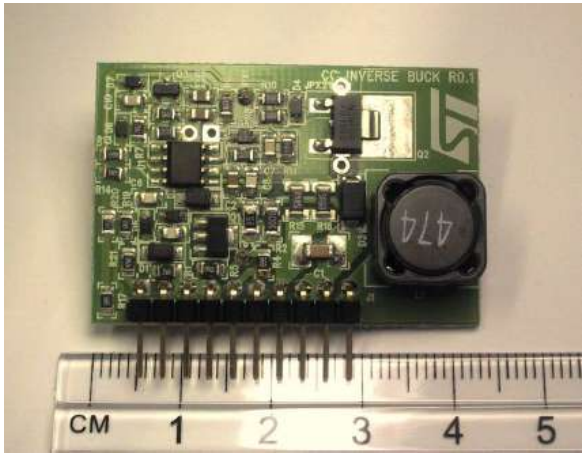


Fast recovery diode
(depends on VIN and LED current)

LV / MDMesh mosfet
(depends on VIN and LED current)

ANALOG SOLUTION

- **L6562A** in fixed freq control



DIGITAL SOLUTION

- **STM8S208*** to direct drive mosfets (Super/Logic level)

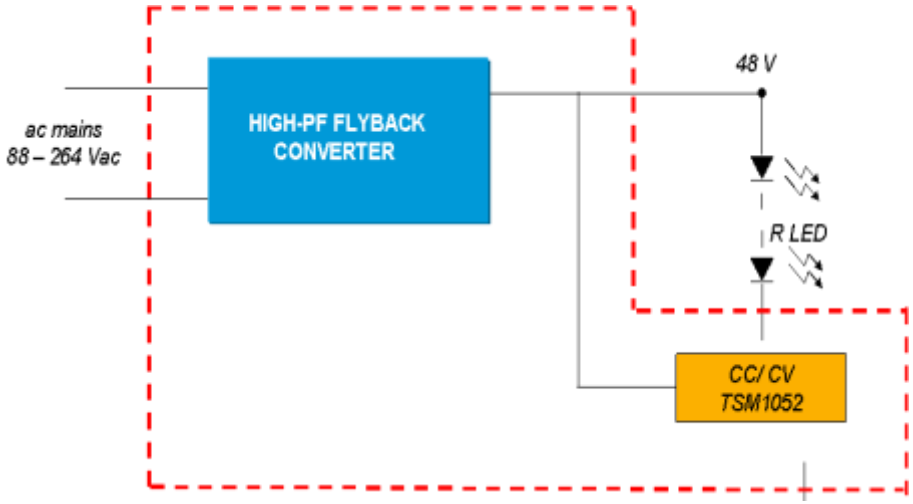
10 to 50W Applications: Transition Mode PFC in Isolated Flyback and inverted Buck Topology

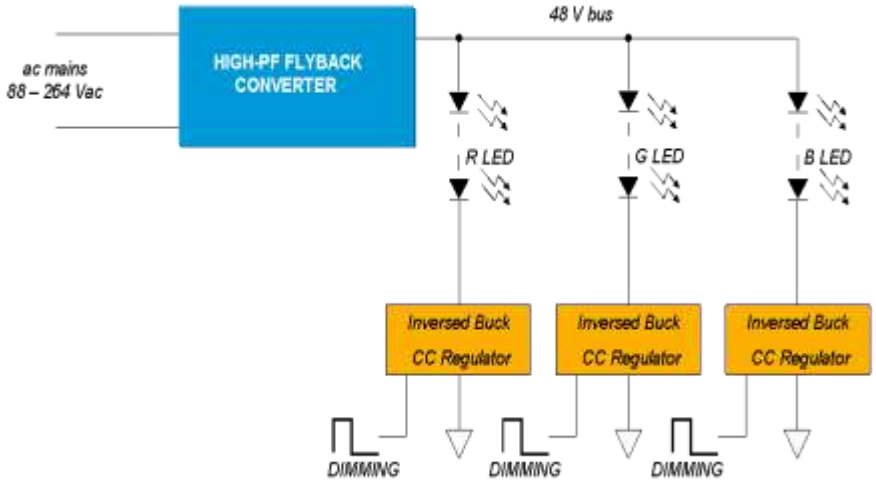
L6562A in high power factor flyback topology

Associated to:

- CC/CV for single LED string like **TSM1052** or new **SEA05**
- inverted buck converter based on **L6562A, DC/DC or linear** converter for multiple LED columns (STEVAL-ILL019V1)

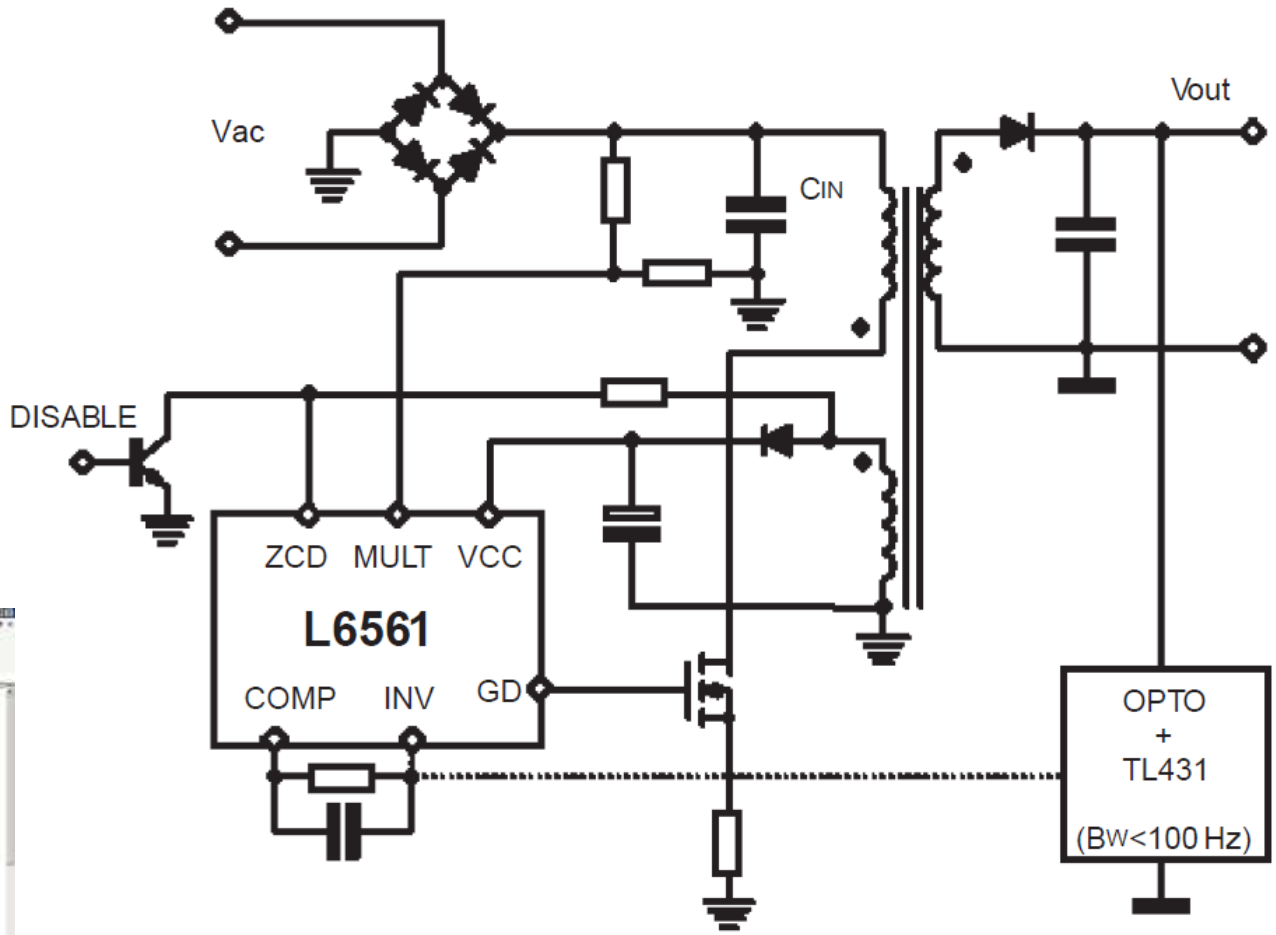
STEVAL-ILL019V1





10 to 50 W Applications: Transition Mode PFC in Isolated Flyback and inverted Buck Topology

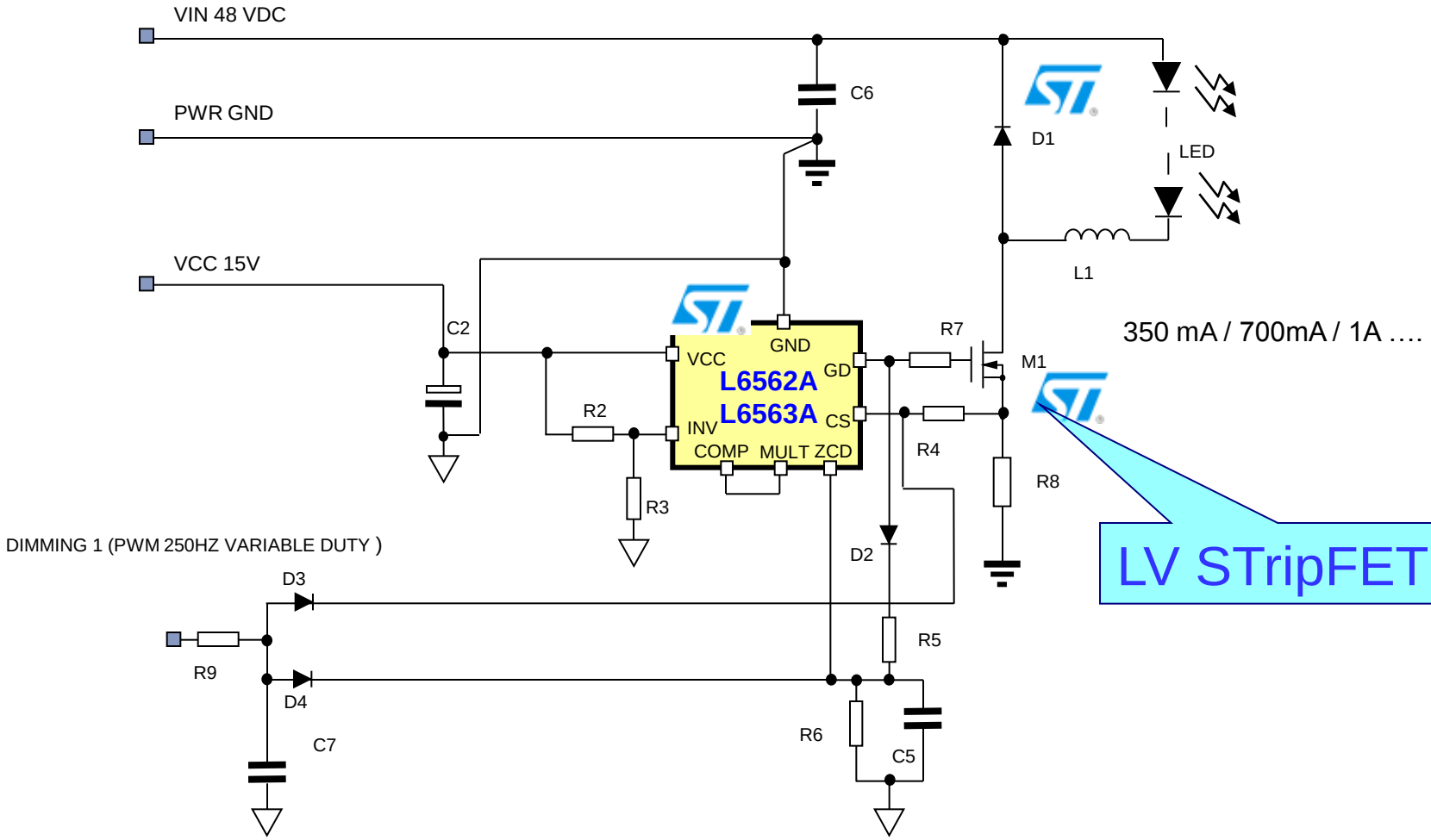
…since January 2000, using the L6561 (now ***L6562A***), the idea was developed of a single stage performing power factor correction and voltage regulation in a single stage



NEVERTHELESS
…spreadsheet available

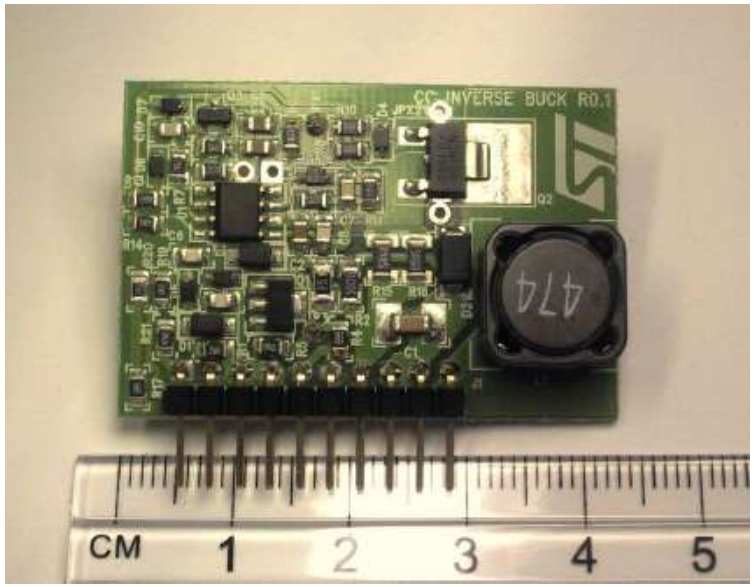
Inverted Buck Topology

- STEP-DOWN based on low voltage controller



EVL6562A: from 48Vdc

Constant current inverse buck LED driver using L6562A



Documentation: AN2983 published

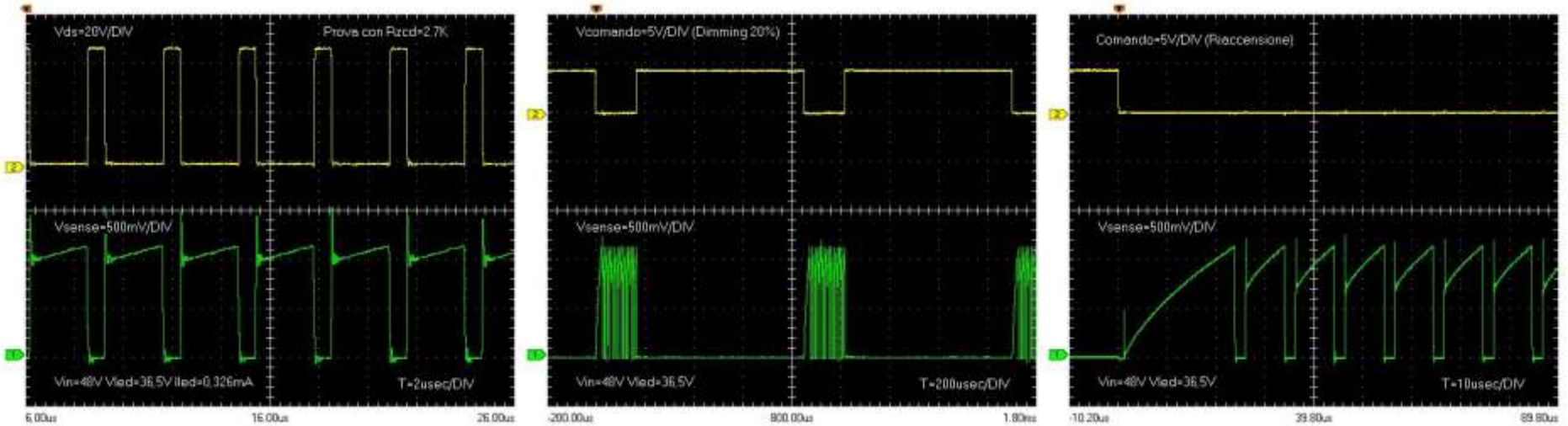
- Input voltage: 48 V (+/- 20%)
- Output current (average): 0.35 A
- Output ripple current < 140 mA (+/- 20%)
- Output current setting/calibration
- Digital dimming
- Open-/short-circuit protection
- Absence of electrolytic capacitors

Key Product:
- ✓ L6562A
- ✓ STPS2H100A
- ✓ STN3NF06

Typical Applications:
- ✓ Street lighting
- ✓ Interior lighting
- ✓ Decorative lighting

EVL6562A: dimming

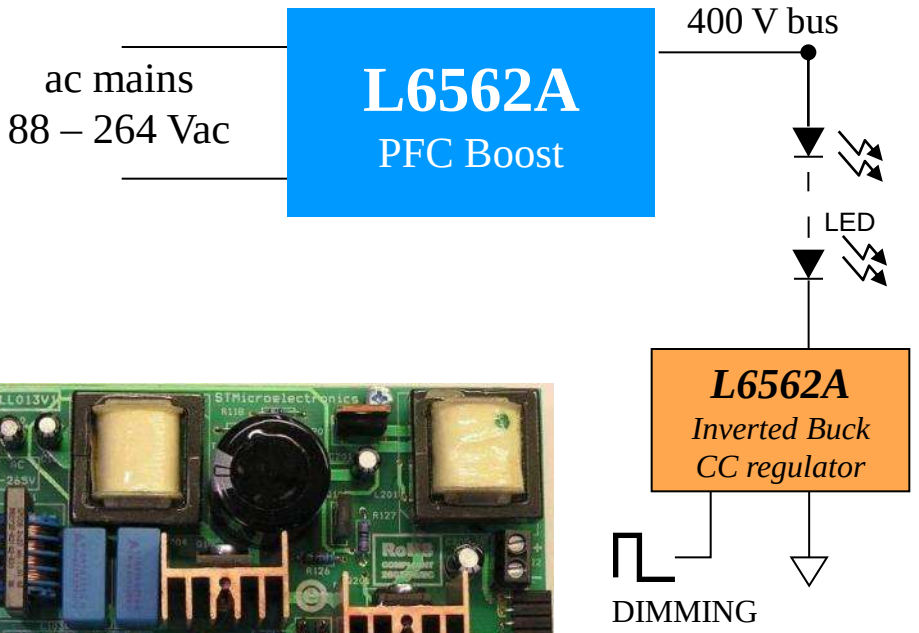
- CC operation up to 600 kHz
- Fixed-Off-Time Peak-Current-Mode control
  - No sub-harmonic oscillation
  - No need for slope compensation
- High-efficiency (>90% with 6+ LEDs)
- Accurate Constant Current set point (<5% tolerance)
- Very deep dimming (<1% @250 Hz) thanks to IC immediate restart



80 W and up Applications (Street Lighting): PFC Boost + inverted Buck Converter

MAIN FEATURES:

- LED current setting to 350mA, 700mA and 1A
- High efficiency (~90%) and high Power Factor
- Wide input voltage range 88V to 265V AC
- Universal PWM input for dimming (ext. board required)
- Not isolated SMPS
- Brightness regulation between 0% and 100%
- EMI filter implemented
- EN55015 and EN61000-3-2 compliant



Ideal for:
Single LED columns

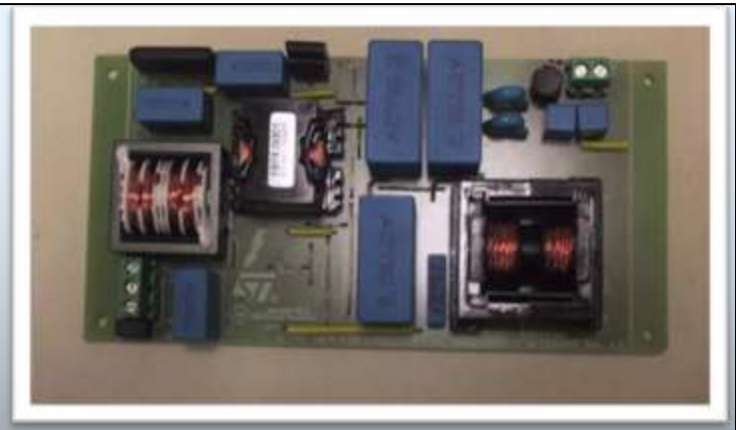
Evaluation board	Application note	Description
STEVAL-ILL013V1	AN2928 UM0670	80W off-line LED driver with dimming based on L6562A

EVL130W-SL-EU + EVL6562A-LED

Isolated 130W converter for LED streetlight systems

- Power factor correction on EU mains (185Vac to 264Vac)
- Output voltage: 48V @ 2.7 A
- Efficiency: >90% @ 115Vac – Full load
- Long life, high MTBF (No EL-CAPS)
- Mains harmonics: according to EN61000-3-2, JEITA-MITI
- EMI: meets EN50022 Class B

- Output current (average): 0.35 A
- Output ripple current < 140 mA (+/- 20%)
- Output current setting/calibration
- Digital dimming
- Open-/short-circuit protection



EVALUATION BOARD
www.st.com/evalboards

RoHS

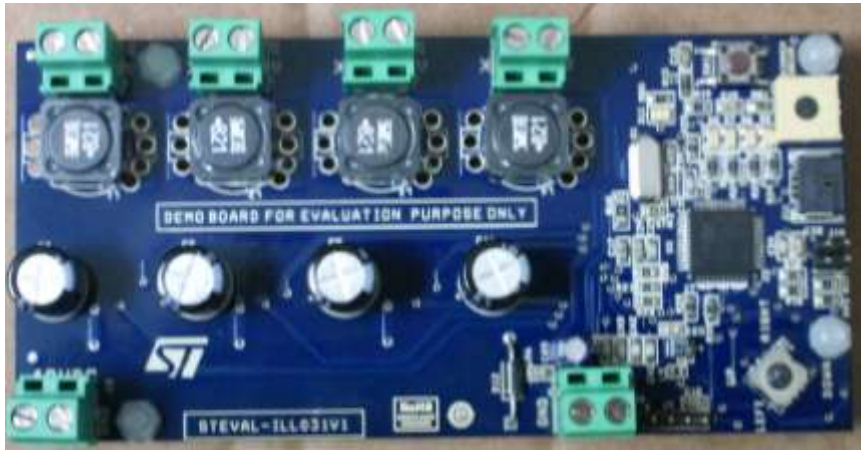
Ordering code: **EVL130W-SL-EU -** On Stock (AN3105)

Ordering code **EVL6562A-LED -** On Stock (AN2983)

STEVAL-ILL031V1: 4 channel digital controlled LED driver

Documentation: AN3151

- DC in voltage 48 VAC
- 4 channels LED driver
- Constant LED current 700mA
- LOAD: 5 to 10 LEDs per each channel
- Rated output power: 130W
- Brightness regulation
- All controlled by STM8S20x
- Power and current flexible solution



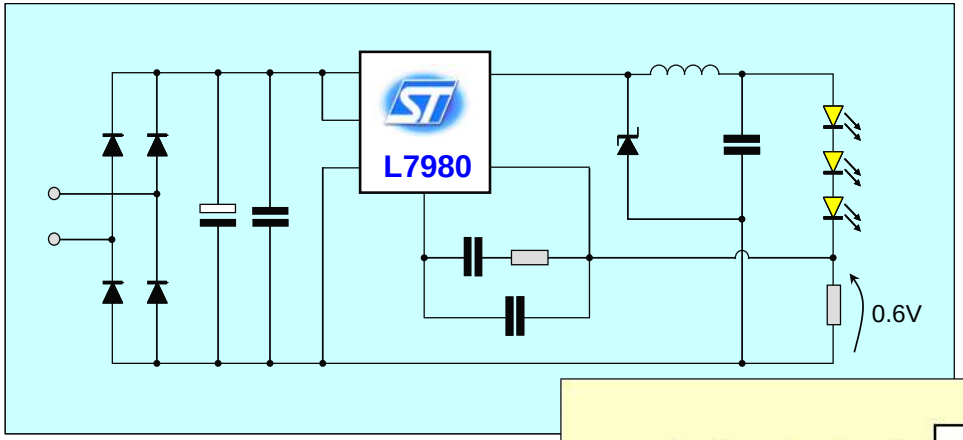
Key Product:
✓**STM8S208RB,**
✓ STN3NF06,
✓ STPS1L60A-SMA,

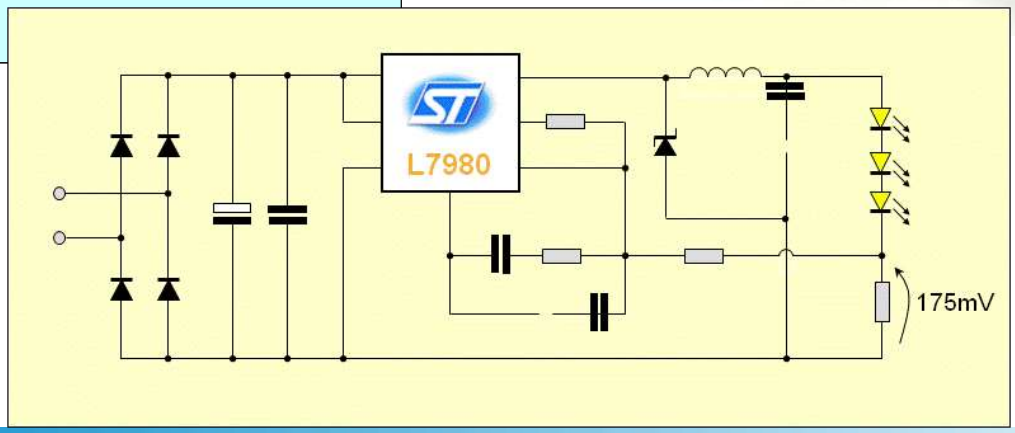
Typical Applications:
✓ Streetlighting
✓Light tiles
✓ General Lighting

Board Purpose:
It shows an innovative solution for multiple stage LED driving when PF, isolation and individual LED brightness regulation are required.

Illumination – low power

- Replacement of existing halogen lamps, few Watts, connected to an electronic transformer (typ. 12V$_{AC}$) based on **L798x** family
- Needs:
  - LED current regulation within a specified tolerance
  - MR-16 compliant (=area and temperature constraints)

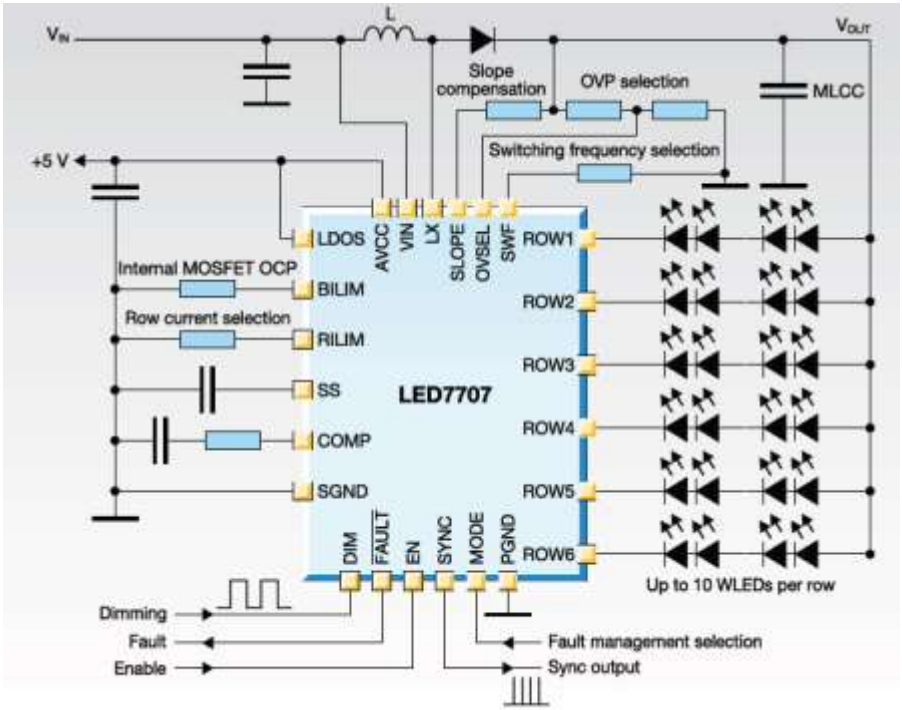




Backlight & emergency light

- Retro-illumination of displays and emergency signs based on **LED770x** family (up to 36V_{IN})

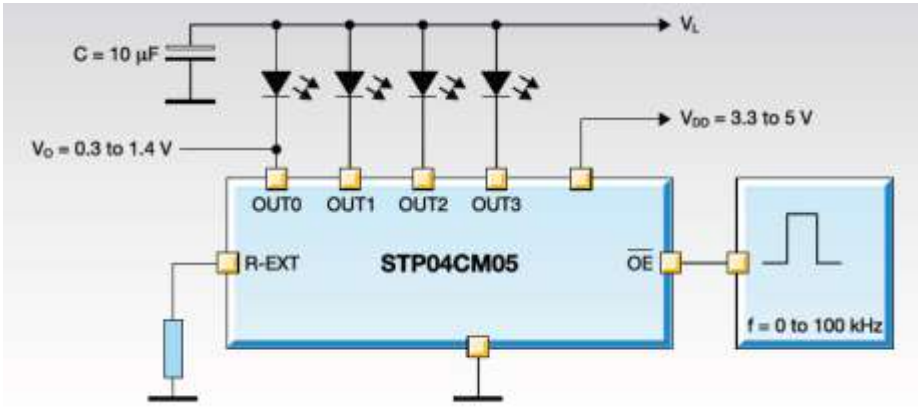
- Needs:
  - Multi channel LED current control
  - Input voltage boosting
  - Interface with a uC



Display / arrays

- Driving LED matrix / arrays by means of a microcontroller serial data-in connection based on **STPxx05x (power logic)** family

  - White goods, power tools
  - Large displays
  - Gaming/gambling machines
  - Sign/signage (variable text messages)
  - Automotive interior and exterior
  - Backlighting
  - Traffic lighting



example

STPxxyy05 features summary

Part Number	#ch	I_{LED} (mA)	ΔI_{LED}		Error detection	Auto Power Saving	Balanced Turn ON/OFF	Grayscale Brightness control	Current Gain Adjustment	Staggered output delay
			Channel to channel (MAX)	IC to IC (MAX)						
STP04CM05	4	80 ÷ 400	±1.5% (80÷400mA)	±6%						
STP08CP05	8	5 ÷ 100	±3% (20÷100mA)	±6%						
STP08DP05	8	5 ÷ 100	±3% (20÷100mA)	±6%	✓					
STP16CP05	16	5 ÷ 100	±3% (20÷100mA)	±5%						
STP16CPS05	16	5 ÷ 100	±3% (20÷100mA)	±5%		✓				
STP16DP05	16	5 ÷ 100	±3% (20÷100mA)	±5%	✓					
STP16DPS05	16	5 ÷ 100	±3% (20÷100mA)	±5%	✓	✓				
STP16CPP05	16	3 ÷ 40	±3% (20÷40mA)	±5%						
STP16CPPS05	16	3 ÷ 40	±3% (20÷40mA)	±5%		✓				
STP16DPP05	16	3 ÷ 40	±3% (20÷40mA)	±5%	✓					
STP16DPPS05	16	3 ÷ 40	±3% (20÷40mA)	±5%	✓	✓				
STP16CPC05	16	5 ÷ 100	±3% (20÷100mA)	±5%			✓			
STP16CPC26	16	5 ÷ 90	±3%	±6%						
STP24DP05	24	5 ÷ 80	±6% (5÷15mA) ±3% (15÷80mA)	±6%	✓					✓
NEW STP24GPL05	24	2÷ 36	±3%	±6%	✓	✓			✓	✓
STP1612PW05	16	3 ÷ 60	±1.5% (3÷60mA)	±6%	✓			✓	✓	✓

Special features of STPxxyy05 family

- ***Error detection*** → *STP16DP05, STP16DPS05, STP16DPP05, STP16DPPS05, STP08DP05, STP24DP05*
- ***Balanced Turn ON/OFF*** → *STP16CPC05*
- ***Auto Power Saving*** → *STP16CPS05, STP16DPS05, STP16CPPS05, STP16DPPS05*

The Error Detection Mode

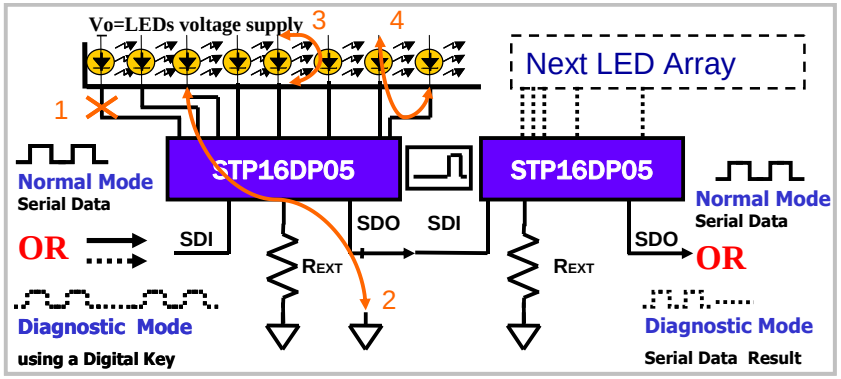
ERROR DETECTION → *Open and short detection on the output*

NORMAL MODE

Device works like a Constant Current LED driver

DIAGNOSTIC MODE

Using a *Digital Key* input to the SERIAL DATA IN (SDI), the LED Driver enters the Diagnostic mode



Detection conditions	Detection results
$I_{ODEC} \leq 0.5 \times I_O$	*OPEN LINE (1) or OUTPUT SHORT TO GND (2) detected*
$I_{ODEC} \geq 0.5 \times I_O$	NO ERROR DETECTED
$V_O \geq 2.4V^*$ (2.6V**)	*SHORT ON LED (3) or SHORT TO V_O (4) detected*
$V_O \leq 2.2V^*$ (2.3V**)	NO ERROR DETECTED

* STP16DP/DPS05

** STP16DPP/DPPS05

I_{ODEC} → detected output current in detection mode

Error Detection available in *STP16DP05, STP16DPS05, STP16DPP05, STP16DPPS05*

Balanced turn ON/OFF

Balanced turn ON/OFF → improves the system performance avoiding ringing or noise generation (EMI problems) due to parasitic inductance

Current

Turn-ON/OFF

Voltage

Turn-ON/OFF

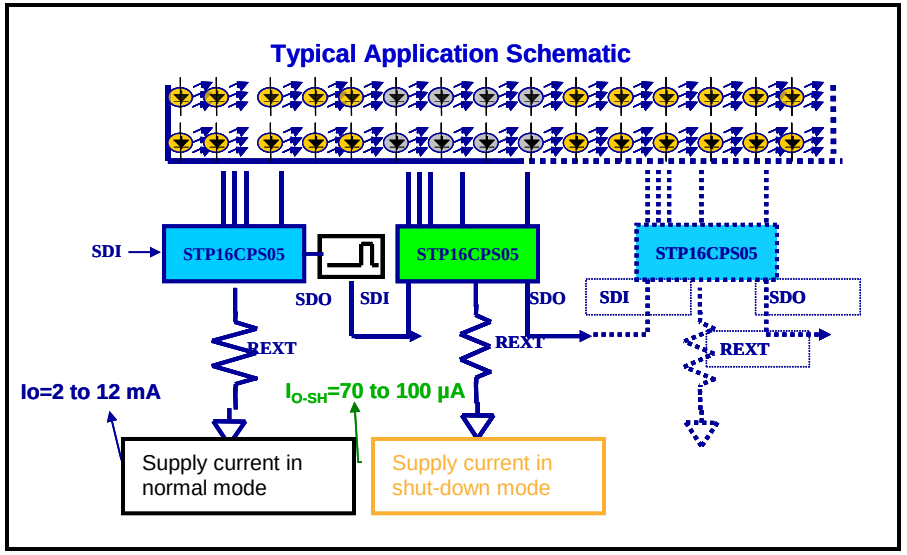
turn ON and turn OFF time typically around 100ns

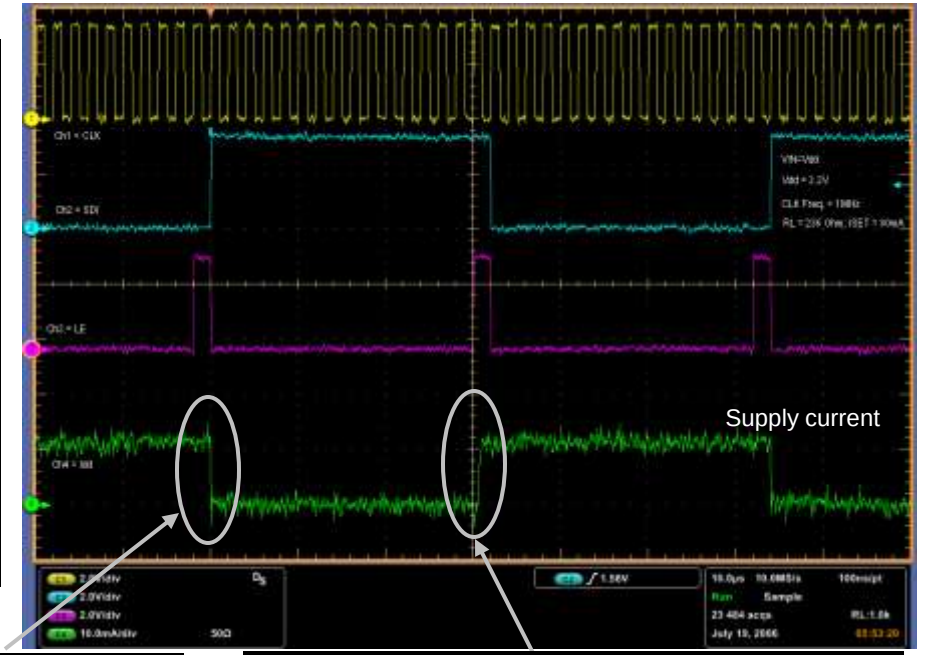
(typical T_{ON} and T_{OFF} of the other products → some tens of nanoseconds)

Balanced turn ON/OFF available in *STP16CPC05*

Auto Power Saving

- The device is able to detect latched data status and if all data latched are LOW (no active channels) goes itself in *Auto-Shut Down* mode .At the first active data latched the device automatically switches to *Auto Power-Up* mode.
- This device is specially suitable for all the battery or solar cell supplied LEDs applications and fit well all the requirements where the power saving is a constraint.





All channels detected LOW→
the device enters the SHUT-DOWN MODE

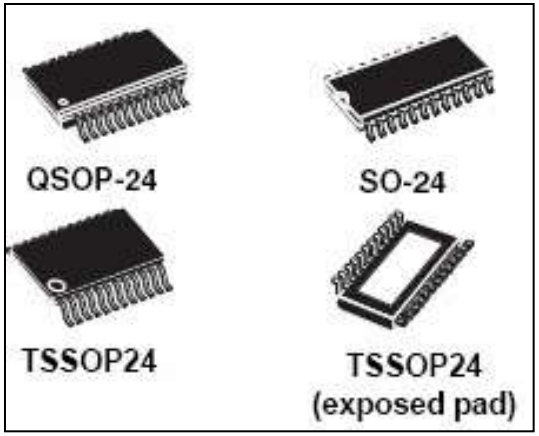
the device automatically switches to
AUTO POWER-UP MODE

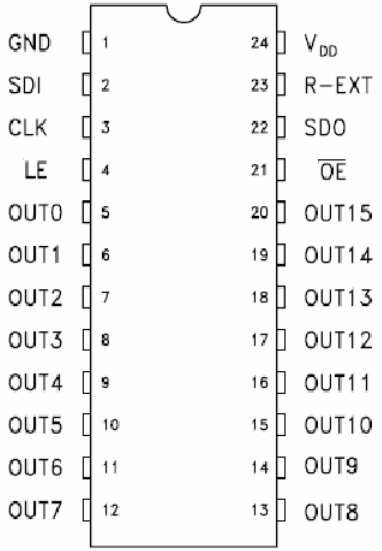
Auto Shut-Down available in *STP16CPS05, STP16DPS05, STP16CPPS05, STP16DPPS05*

STP16CPC26 – main features

MAIN FEATURES

- 16 constant current output channels
- Adjustable output current through external resistor
- Output current: 5mA to 90mA
- Current accuracy: ±3% bit-to-bit, ±6% IC-to-IC
- Almost balanced T_{ON}/T_{OFF}
- Max clock frequency: 30MHz
- 20V current generators rated voltage
- 5V power supply





STP16CPC26 vs STP16CPC05

COMMON FEATURES

#channels	16
Current accuracy	±3% max bit-to-bit, ±5 (CPC05)/±6%(CPC26)max IC-to-IC
Available packages	 QSOP-24 SO-24 TSSOP24 TSSOP24 (exposed pad)

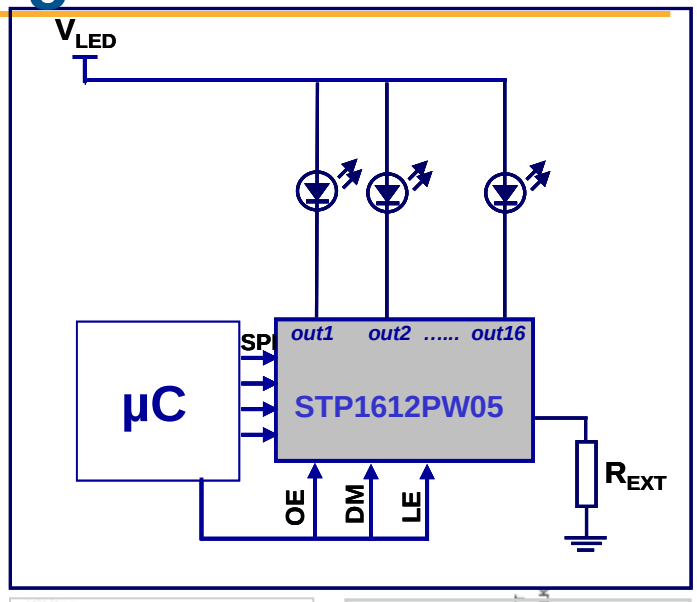
DIFFERENTIATING FEATURES

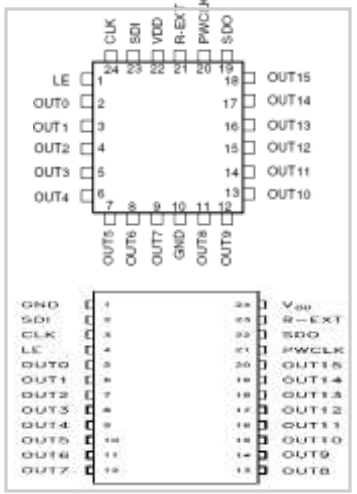
	STP16CPC26	*STP16CPC05*
Output rise/fall time (T_{ON}/T_{OFF})	almost balanced	Balanced
Output current range	5÷90mA	5÷100mA
Supply voltage	5V	3V to 5V
Hysteresis between input voltage high/low levels	wide	Narrow
Silicon area	STP16CPC26 smaller than STP16CPC05	

STP1612PW05 – 16 channels, 3-60mA LED driver, 12/16 bit Gray-scale, 8-bit current gain control

Main features

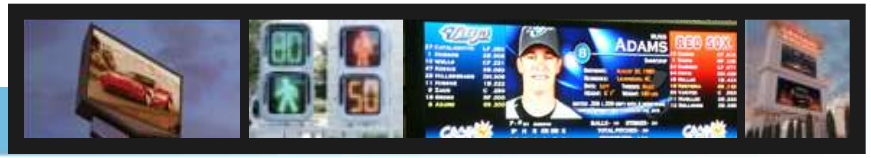
- 16 constant current output channels
- Adjustable output current through one external resistor (3-60mA)
- Selectable 12/16-bit ***gray-scale*** brightness control
- Selectable **enhanced PWM** for “ghost effect” reduction
- Short and open LED detection
- 8-bit current gain control, 256 steps in two selectable ranges
- **Gradual output delay** (40ns for each group of 4 channels)
- Selectable 16-bit/256-bit serial data in format
- 30MHz clock frequency



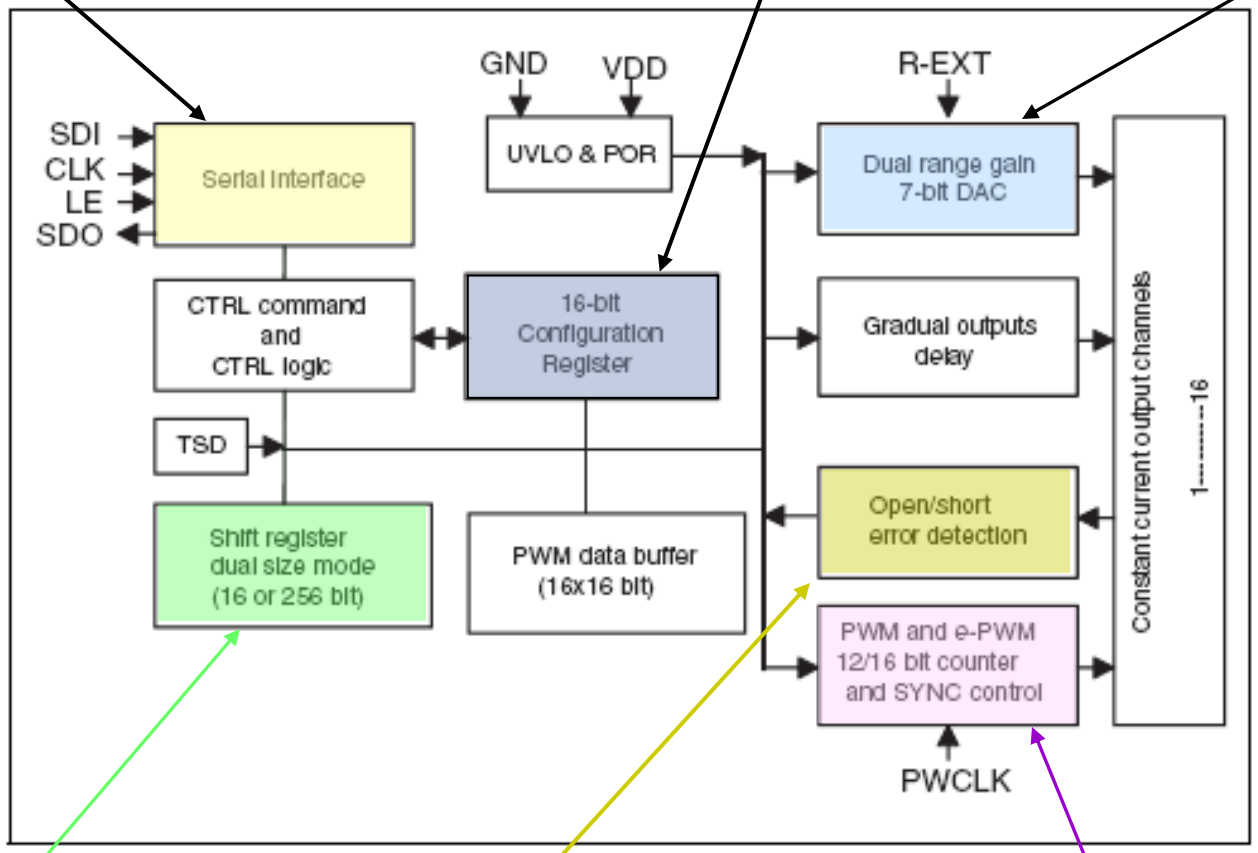


Applications

- Video display LED panels
- RGB backlighting
- Special lighting



STP1612PW05 – Block diagram

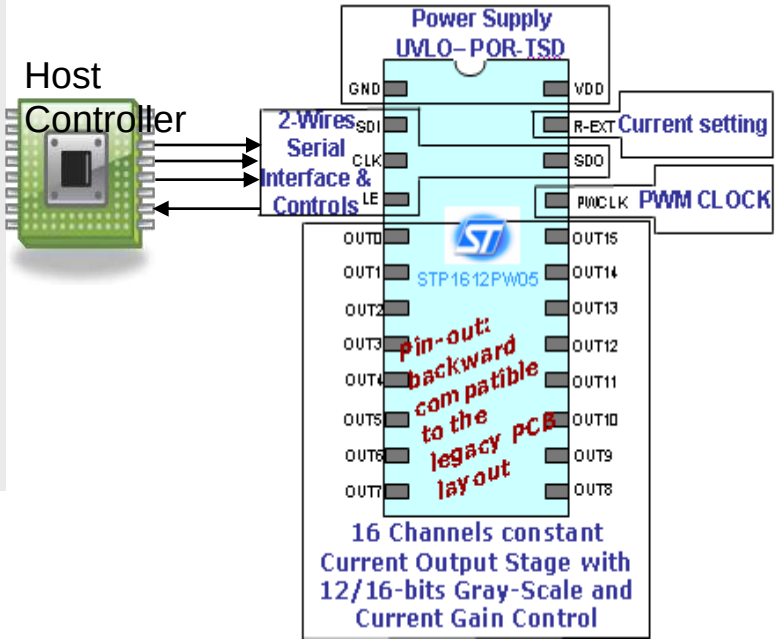


STP1612PW05 – Main functions

Functions accessible via

Serial Key

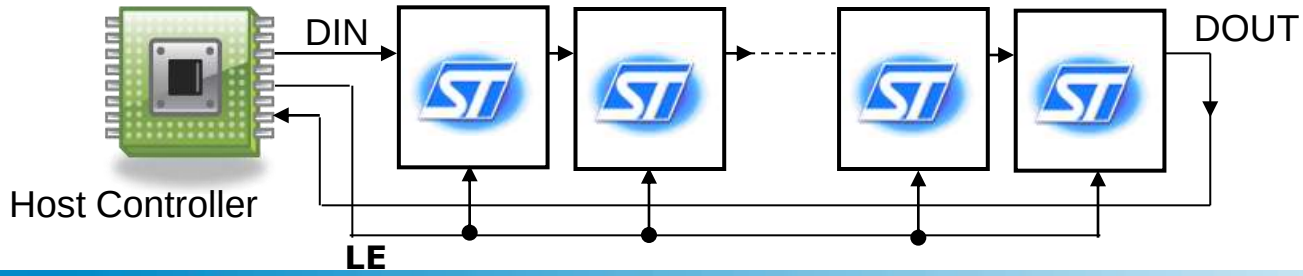
- ✓ ***Data Latch***
- ✓ ***Buffer latch***
- ✓ ***Read Configuration***
- ✓ ***Enable Error Detection***
- ✓ ***Read Error Status***
- ✓ ***Write Configuration***
- ✓ ***Reset Register length***



Functions accessible via Configuration Register

- ✓ ***Set 16 or 256 SR length***
- ✓ ***Read Thermal Flag***
- ✓ ***Enable Thermal Shutdown***
- ✓ ***Set PWM Counter 16 or 12 bit***
- ✓ ***Set PWM or Enhanced PWM mode***
- ✓ ***Set Auto Sync or Manual Sync***
- ✓ ***Set Current Gain***
- ✓ ***Enable PWMCLK time out disconnection***

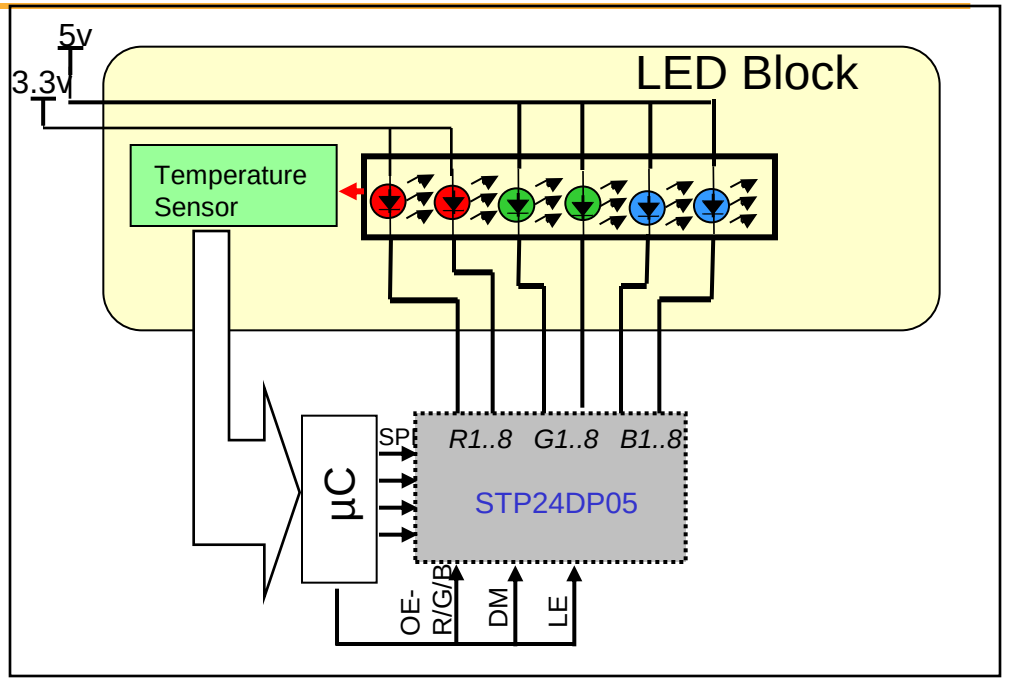
Daisy chain ..with status read back

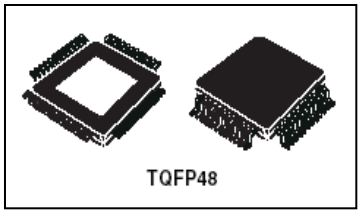


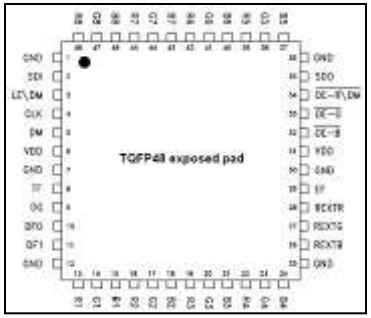
STP24DP05 – 24 channels, 5-80mA LED driver

Main features

- 8 x 3 Channel groups of constant current output channels
- Adjustable output current through one external resistor for each group of 8-channel (5-80mA)
- Short and Open Output Error Detection
- Serial Data IN / Parallel Data OUT
- Gradual output delay (30ns for each group RGB)
- Low voltage power supply (3V to 5.5V)
- Thermal Shutdown with flag pin
- 25MHz Clock Frequency







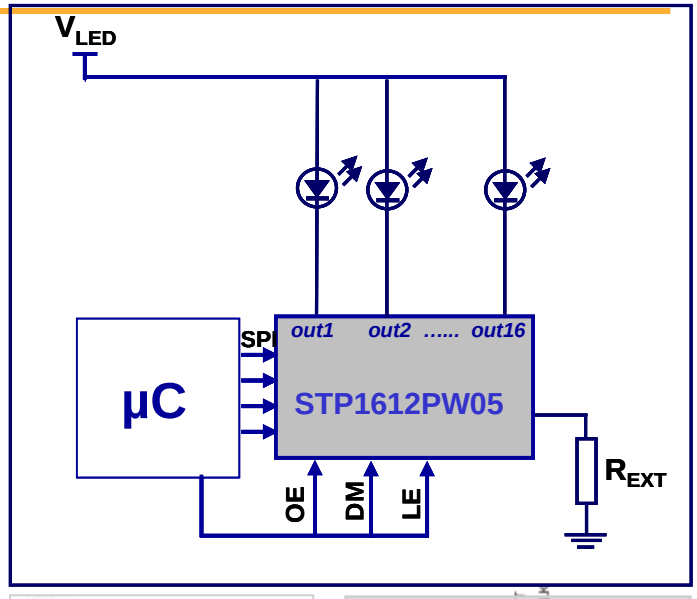
Application

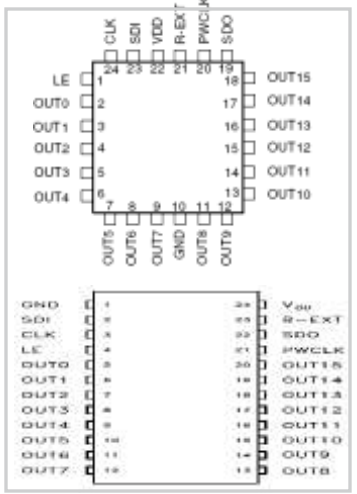
- Full-color High Resolution LED Display
- Colored Traffic Signs

STP1612PW05 – 16 channels, 3-60mA LED driver, 12/16 bit Gray-scale, 8-bit current gain control

Main features

- 16 constant current output channels
- Adjustable output current through one external resistor (3-60mA)
- Selectable 12/16-bit *gray-scale* brightness control
- Selectable enhanced PWM for “ghost effect” reduction
- Short and open LED detection
- 8-bit current gain control, 256 steps in two selectable ranges
- Gradual output delay (40ns for each group of 4 channels)
- Selectable 16-bit/256-bit serial data in format
- 30MHz clock frequency

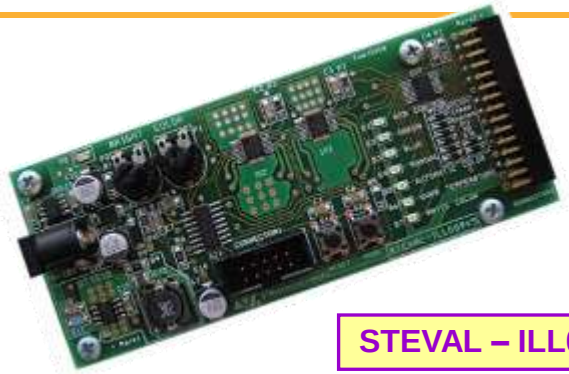




Applications

- Video display LED panels
- RGB backlighting
- Special lighting

STPxxyy05 Demonstration boards



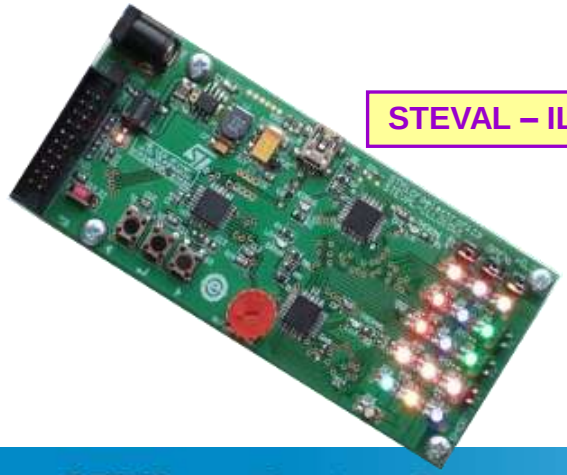
STEVAL – ILL009V5

STEVAL – ILL009V4

STEVAL – ILL003V1

STEVAL – ILL009V3

STEVAL – ILL002V3



STEVAL – ILL015V1

STEVAL – ILL028V1

Demonstration boards

Order code	Description	Device	Feature	Documentation
STEVAL – ILL002V3	40 LEDs Diagnostic reference board	STP08DP05	• Adjustable brightness • Adjustable blinking speed • Animated text • Error detection	AN2415 AN2478 UM0181
STEVAL – ILL003V1	32 LED array reference board	STP16CL596	• Adjustable brightness • Adjustable blinking speed • Animated text	AN2141
STEVAL – ILL003V2	32 LED array reference board	STP16DP05	• Adjustable brightness • Adjustable blinking speed • Animated text	AN2141
STEVAL – ILL009V3 STEVAL – ILL009V4 STEVAL – ILL009V5	• RGB color control driver board • OSTAR projection module • Golden Dragon LEDs	STP04CM05	• Adjustable brightness • Adjustable blinking speed • Animated text • Over temperature protection • Power LED driving	AN2531
STEVAL – ILL015V1	16 RGB LED array based on STP24DP05 and STM32F103C6	STP24DP05	• Adjustable brightness • Mini USB port for PC GUI connection • Error detection	UM0574
STEVAL – ILL028V1	16 RGB LED array based on STP1612PW05 and STM32F103C6	STP1612PW05	• Adjustable brightness • Mini USB port for PC GUI connection • Error detection	-

STEVAL – ILL015V1

Demonstration board features

- *STEVAL-ILL015V1* uses two *STP24DP05*
- 16 RGB LEDs matrix
- Open and short LED simulation
- Open and short LED simulation
- Diagnostic of faulty LEDs by software
- PC connection through USB port
- Color control
- Animated text

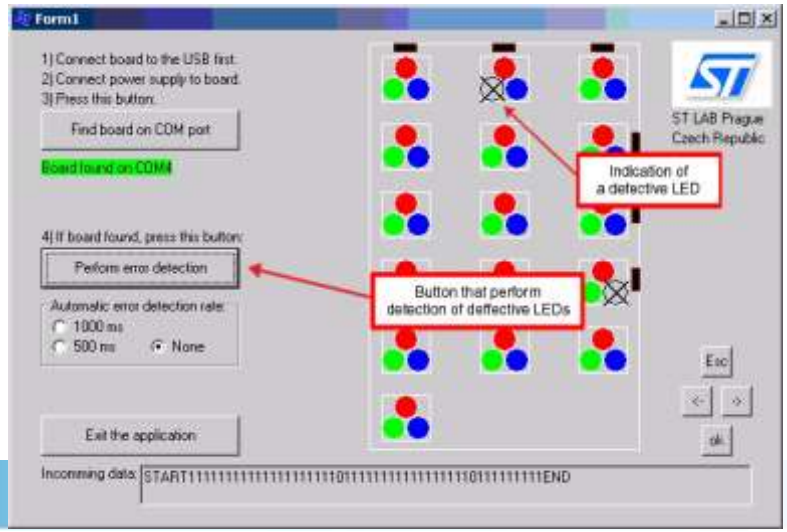
ST Products involved:

- two STP24DP05
- STM32F103C6T6 (microcontroller)
- ST1S10PHR (step-down regulator)
- LD3985M33R (LDO regulator)
- USBUF01P6 (line termination for USB port)

Board purpose

- capability of STP24DP05 to drive RGB LEDs, controlling color and brightness of the emitted light
- Faulty LEDs detection

Graphic User Interface for error detection of faulty LEDs and remote control of the demo board



STEVAL – ILL028V1

Demonstration board features

- *STEVAL-ILL028V1* uses two *STP1612PW05*
- 16 RGB LEDs matrix
- Open and short LED simulation
- Open and short LED simulation
- Diagnostic of faulty LEDs by software
- PC connection through USB port
- Color control
- Animated text

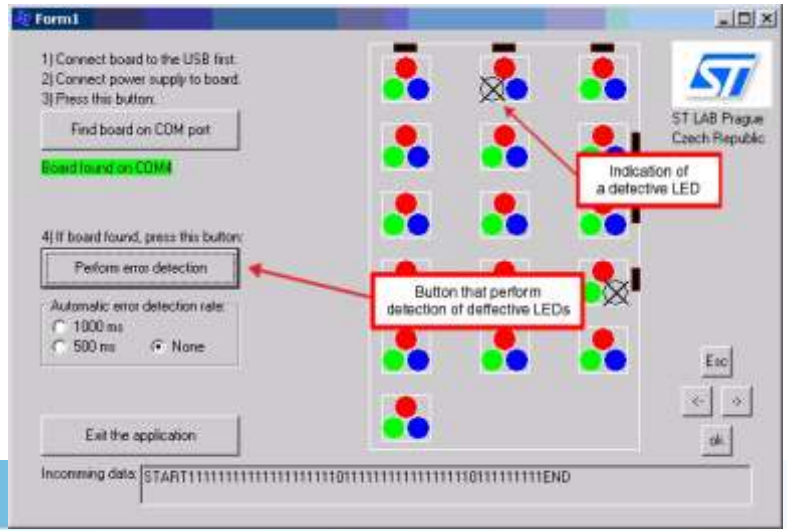
ST Products involved:

- two STP1612PW05
- STM32F103C6T6 (microcontroller)
- ST1S10PHR (step-down regulator)
- LD3985M33R (LDO regulator)
- USBUF01P6 (line termination for USB port)

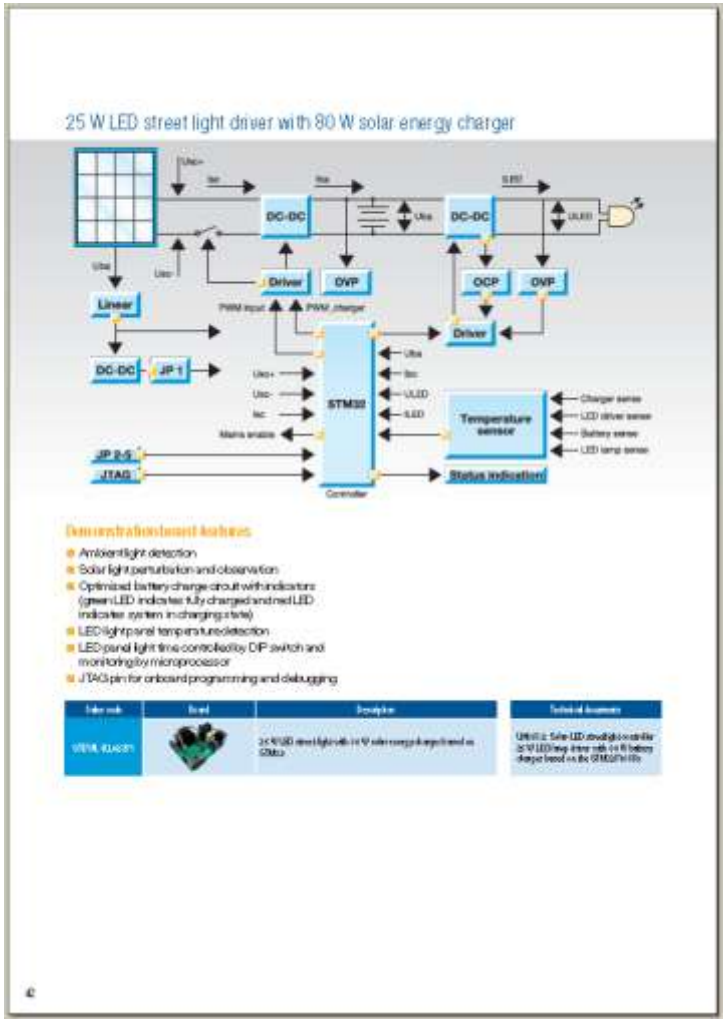
Board purpose

- capability of STP1612PW05 to drive RGB LEDs, controlling color and brightness of the emitted light
- Faulty LEDs detection

Graphic User Interface for error detection of faulty LEDs and remote control of the demo board



Energy-Efficient Solutions for LED Lighting: Brochure



http://www.st.com/stonline/products/promlit/pdf/brlighting0510.pdf

Driving LEDs using DC-DC Switching Regulators

Monolithic solutions offer high efficiency and compactness, wide input voltage range and high current capability for a variety of applications, high dimming performance for superior brightness uniformity

DC BUS powered applications

Up to 48 V

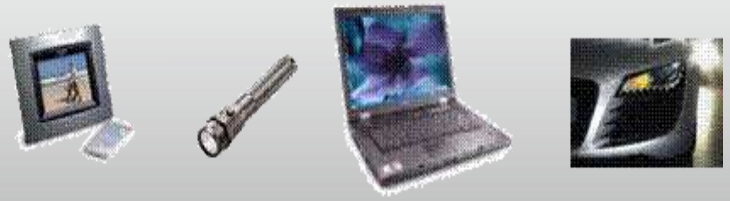
LED770x

L598x | L7980/1 | L7985/6 | L7987/8 up to 63 V in development

L597x | L6902 | L692x | ST1S10 | L6726A*

* PWM Controller

Battery powered applications



• Single & multiple Li-Ion, Ni-MH and alkaline battery systems
• Automotive battery range

LED770x | PM6600

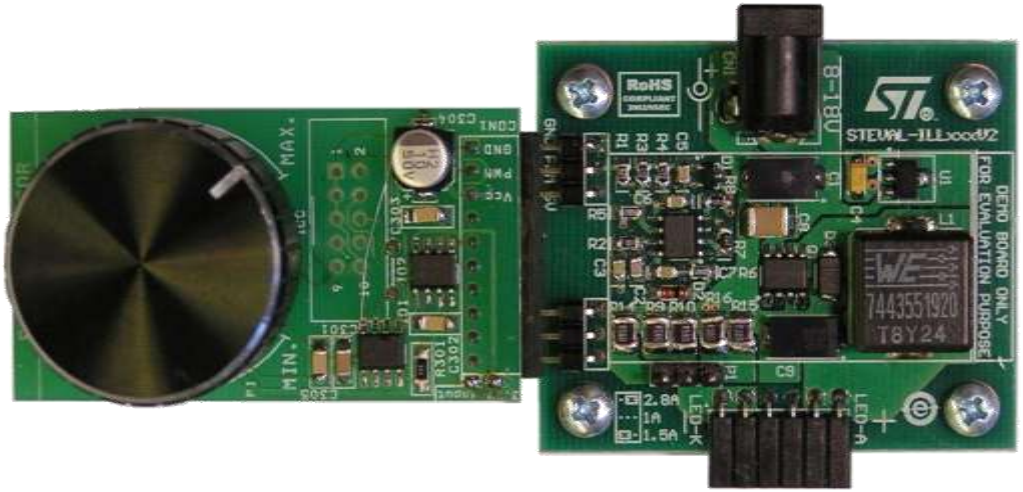
A597x | L692x

STLA02 | L6920 | STCF07

Buck topology (Typical) | Boost topology for multi-rows applications | Boost topology | Buck Boost topology

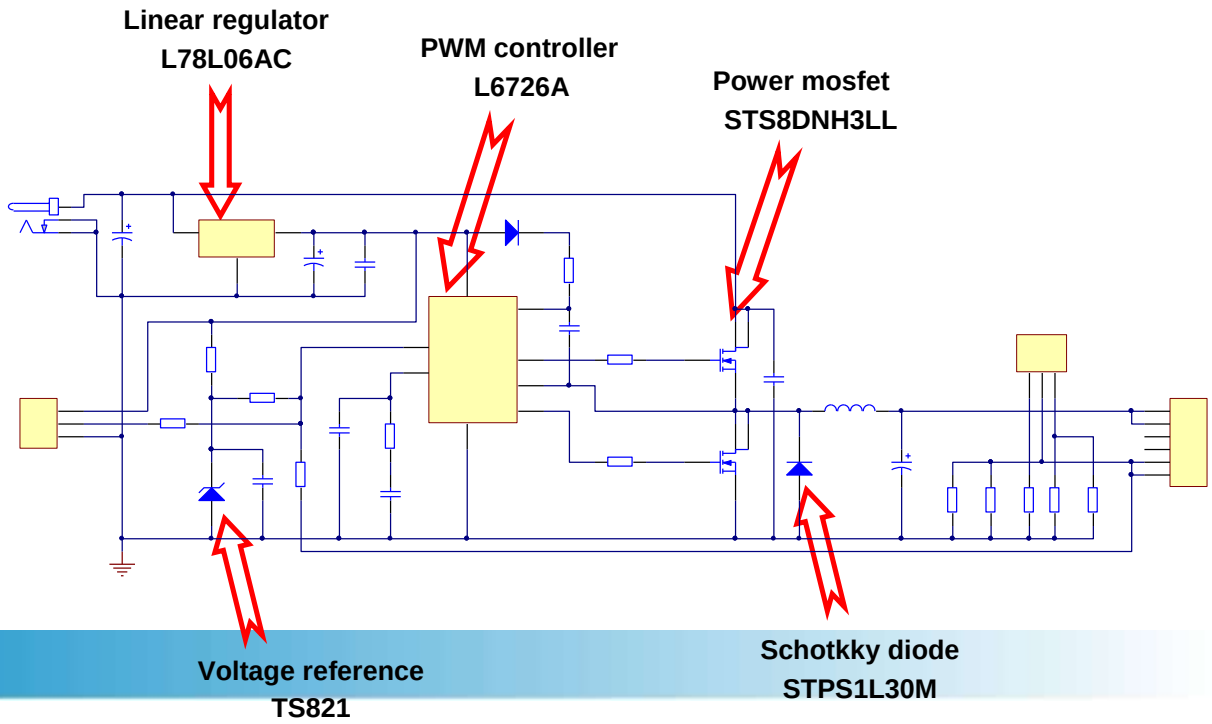
L6726A: High Efficiency Switching LED Driver for High Currents LEDs

- **Functionalities:**
  - Buck topology
  - Input voltage Vin: 8V to 18V
  - Output voltage (with Vin= 18 V): 2.5V to 14 V
  - Output current ILED: 1A / 1.5A / 2.8A
  - Analog dimming (with ILED= 0 A) : 0V to 2.5V
  - Low level PWM signal: 0 V
  - High level PWM signal: 2.8V to 3.8V (typ.: 3.3V)
  - Duty cycle (at fdim = 200 Hz) : 0% to 99%
  - Efficiency (with Vin =18 V and Vout = 12.6V): 94.8%



- **Main efficiency factors**
  - Synchronous rectification
  - Decreased feedback voltage from 0.8V to 0.28V
  - Mosfet with Rdson 20mW
  - Inductor with DC resistance 7.8mW

Ideal for:
General lighting , Reading lighting, Cabinet Lighting
Architectural lighting
Reading lighting, Cabinet Lighting



Why remote control

Different needs for remote control

- **Energy saving**:
  dimming according to natural light, *on-off* according to room occupancy…

- **Comfort**:
  color changing (cool/warm) based on location and time of the day. Improved productivity at work, more relaxing at home

- **Architectural/fashion**:
  Create different *effects* using same lights Scene setting for Lounges, Hotels, Restaurants, shops. Building illumination.

- **Light control**:
  for specific application like theater, stage lighting…

Additional details on Remote Control

Different technologies for different needs

- Wireless
  - **Zigbee** with Pro-Stack
- Wireline:
  - **DALI**
  - **DMX512**
  - **Power Line Communication**

+ **BACnet** and on going **KNX** porting in STM8L (TP)

DALI

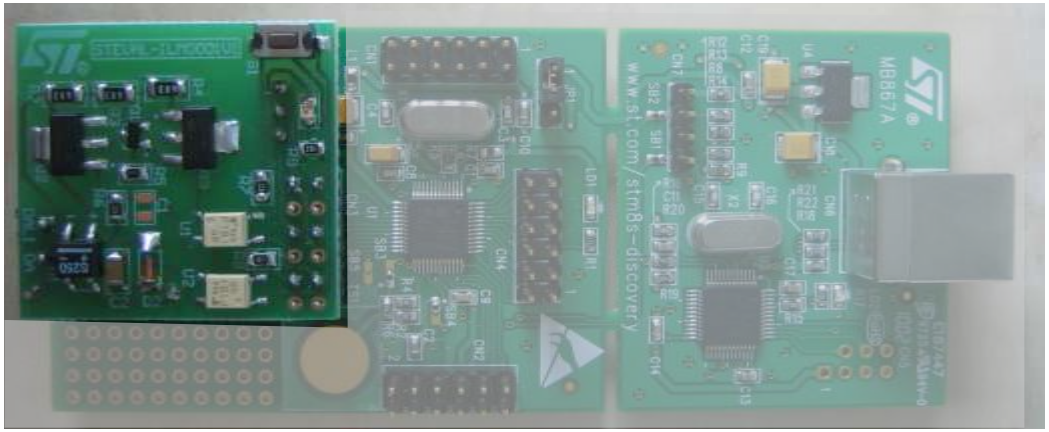
Digitally addressable lighting interface

STEVAL-ILM001V1 - description

DALI communication interface - plug-in module for STM8S-Discovery

SW Library
- DALI physical layer (GPIO toggling)
- DALI stack
- New DALI standard compatible
- Example for STM8S-DISCOVERY

HW module
- Isolated DALI interface
- Level translation for microcontroller
- Current consumption limiter



Documentation:

UM1032 (board) soon to be published
AN3298 (SW Library) soon to be published
SW code soon on www.st.com/stm8s -> Resources -> Firmware

Key Product:
- ✓ STM8 family
- ✓ STN1HNK60
- ✓ STN93003

Typical Applications:
- ✓ Home/building automation
- ✓ Lighting

Board Purpose:
Make the DALI communication available also on STM8 microcontrollers and have a simple demonstrator. Allow targeting medium/small size customers for lighting control

Note: STM8S-DISCOVERY is not included in the STEVAL-ILM001V1

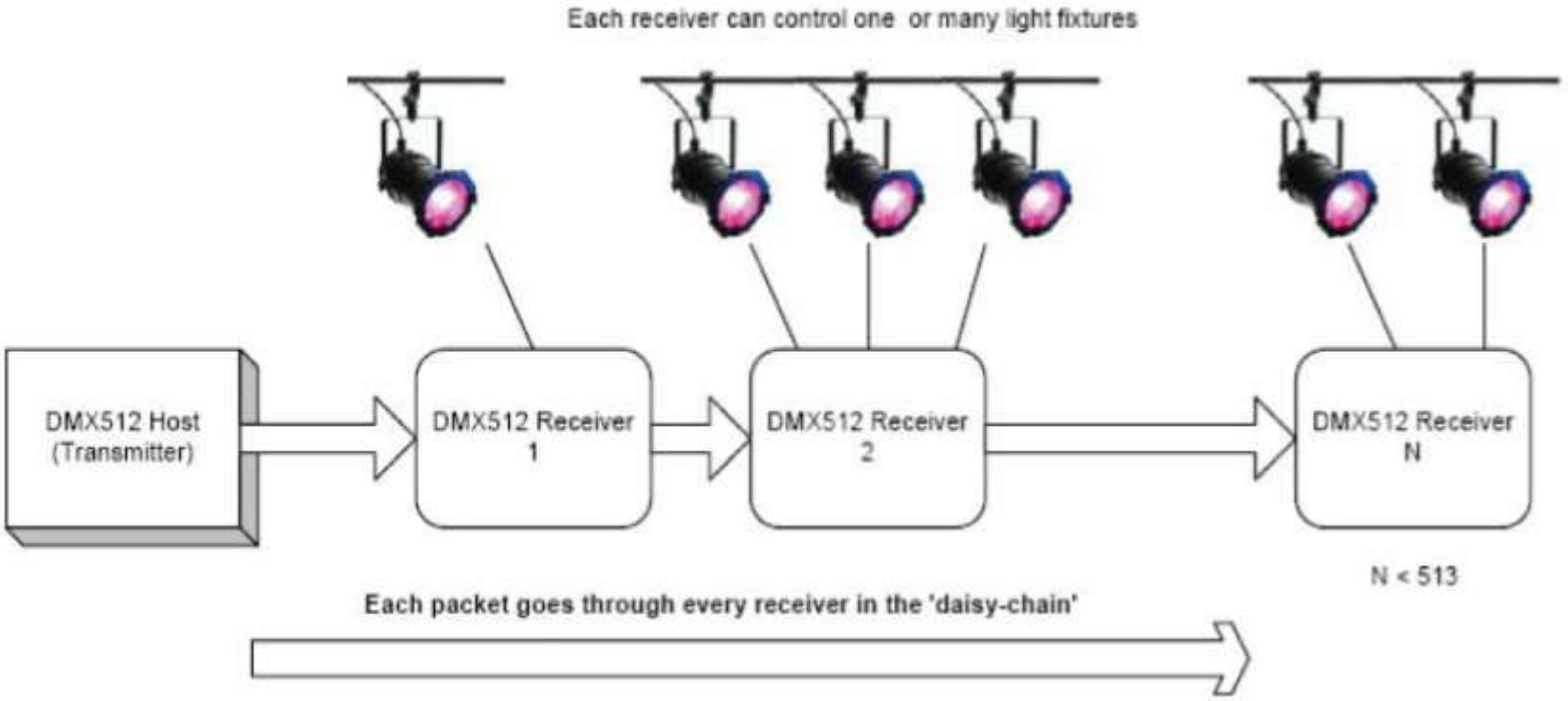
SW Library

- Main user application
  - Example for STM8S-Discovery
- DALI stack layer
  - DALI commands implementation
  - HW independent (easily portable to STM32)
- IO pin driver
  - Physical and link layer of DALI interface (bit timing, bus error recovery control, DALI frames transmission/reception)
  - Occupied resources:
    - 2 GPIO pins – selectable (RX and TX) + 1 GPIO interrupt
    - 1 Timer4 (DALI protocol timing) + 1 Timer interrupt

DMX512

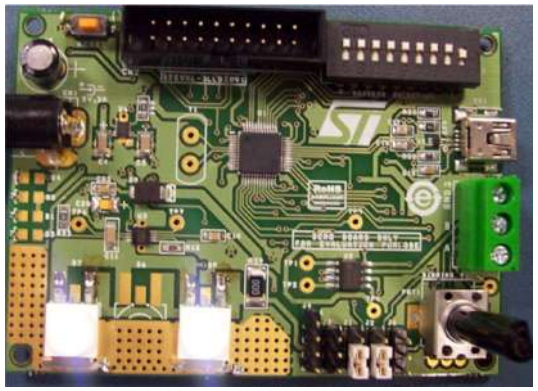
DMX

- DMX512-A is EIA-485 based standard for Wired Communication (twisted pairs + RS485 as PHY) used in Theatre Stage Lighting and Exhibition Lighting
- DMX512 uses asynchronuos data trasnsmission up to 250Kb/s (to dimmers, scanner, motorized o decoder). Serial transmission and daisy chain configuration up to 512 nodes with max time 22ms (no delay visible)



STEVAL-ILL030V1 - description

Ref. design and DMX512 communications protocol algorithm based on STM32



- Follows DMX512 2008 Standard as well as timing constraints
- Configuration of a single board mode as transmitter, receiver or standalone
- LED Intensity Control using a 120Hz PWM from 0% to 100%
- Connection to multiple receivers up to 512 to a single host controller
- False packets rejection, reset sequence timing checking
- Two on-board 3W LEDs and jumper option for driving external LEDs

Documentation:

- **UM1004** (user manual) DMX512 based LED lighting solution
- **UM0792:** Demonstration firmware for the DMX-512 communication protocol **transmitter** based on the STM32F103Zx
- **UM0791**: Demonstration firmware for the DMX-512 communication protocol **receiver** based on the STM32F103Zx
- **SW code (.hex)** available with the board. The application source (IDE IAR Embedded Workbench) is available only on request and it is covered by license agreement.

Key Product:

✓ STM32F103
✓ LDS3985M33R (voltage reg)
✓ STCS1APUR
✓ ESDAULC6-3B6 (USB protection)
✓ STBP120AVDK6F (voltage prot.)
✓ ST485ABDR

Typical Applications:

✓ stage lighting
✓ Theaters
✓Choreographic lighting
✓ automatic light systems

Board Purpose:
Make the DMX512 communication available also on STM32 microcontrollers and have a simple demonstrator. Allow targeting medium/small size customers for lighting control

ZigBee

IEEE 802.15.4 open platform

Smart energy

Home & building automation

Wireless sensor network

Healthcare

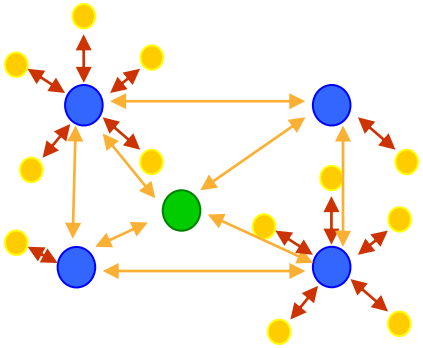
Consumer
Remote control
Home automation

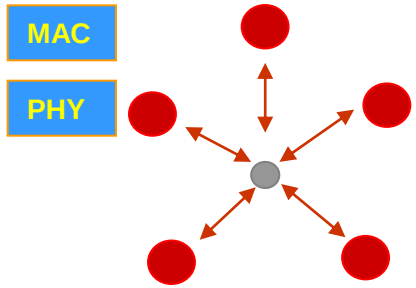
Mesh networking / performance /secured Stacks

ZigBee or similar

Star / PtoP networks / Cost optimized

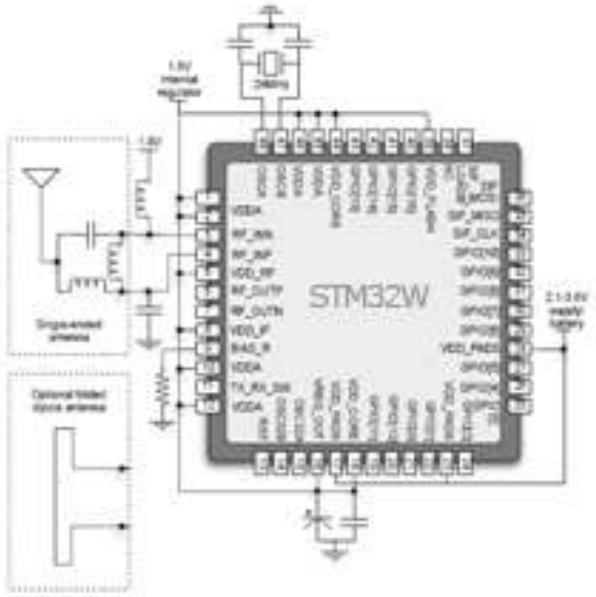
RF4CE or similar



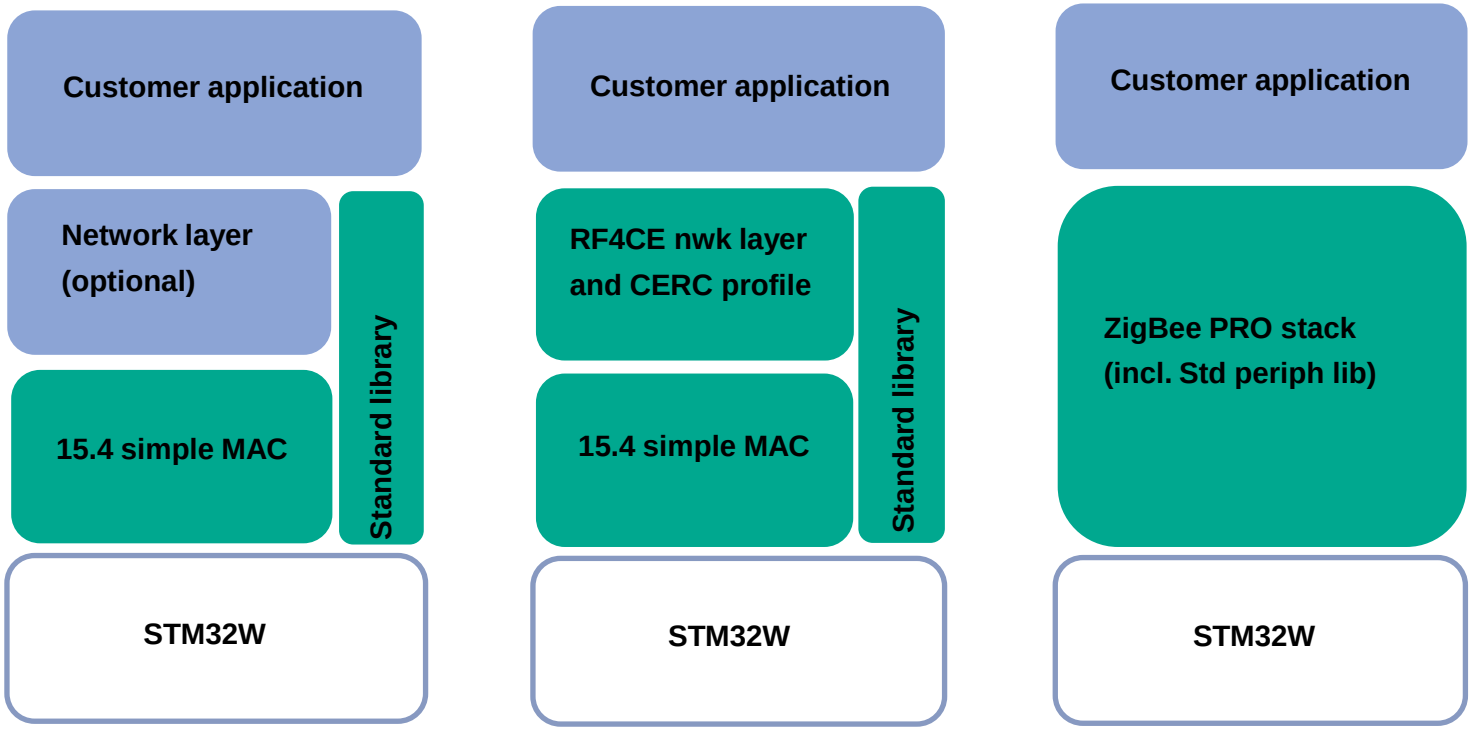


STM32W – IEEE 802.15.4 radio/open platform

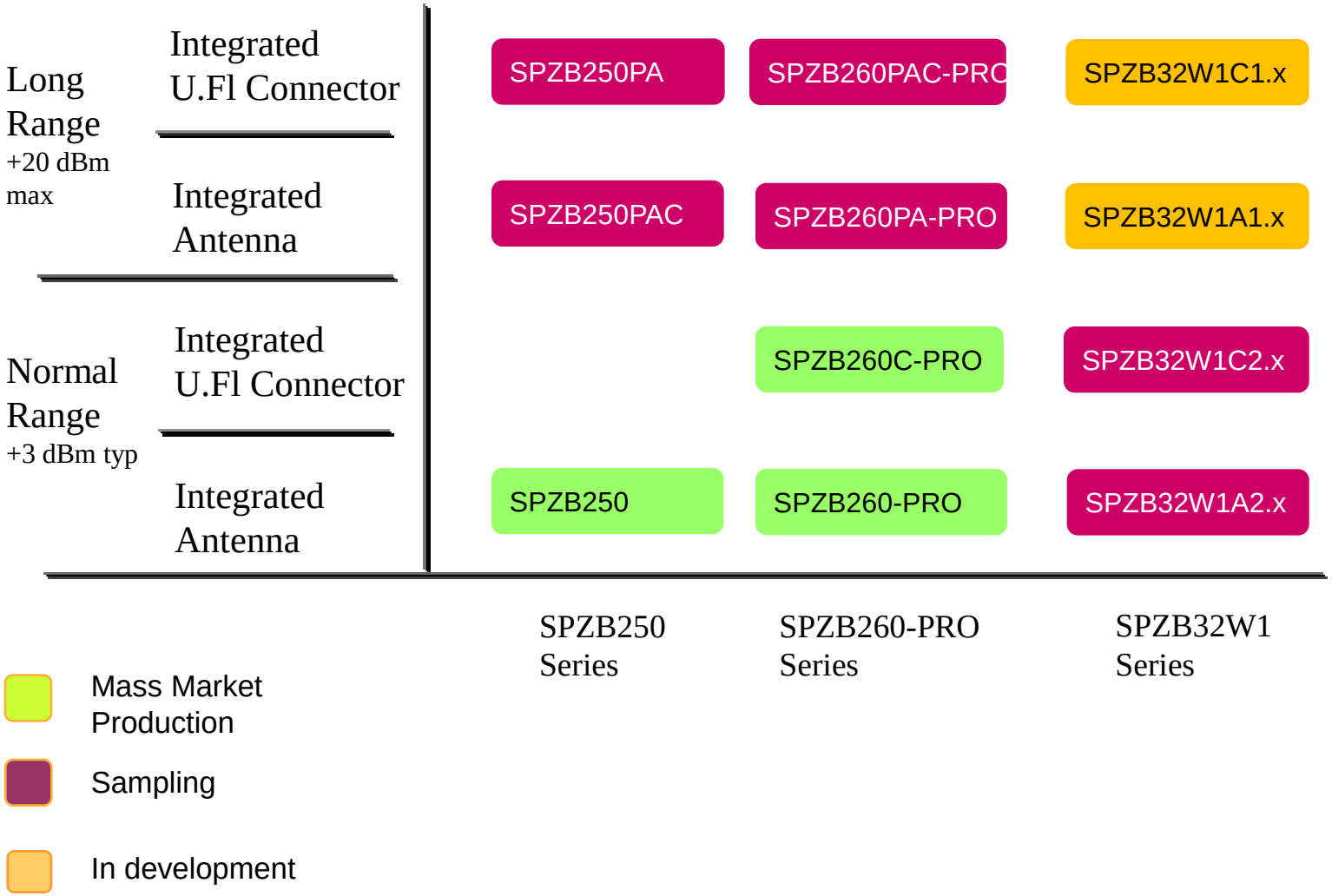
- **IEEE 802.15.4 / 2.4Ghz Radio**
  - Transmitter: 2-point direct synthesizer modulation
  - Receiver: low IF super heterodyne architecture
  - Digital BB DSP & MAC support
  - -100 dBm sensitivity and up to 7dBm output power
- **Microcontroller**
  - ARM Cortex-M3 core architecture
  - Embedded memory (eFlash 16kx64, SRAM 4kx16)
- **Networking**
  - Zigbee compliant PRO stack w/ some enhancements
  - 128 Kbytes Flash for stack & apps codes
- **Peripherals**
  - AES encryption HW accelerator
  - Debug channel via JTAG
  - USART, SPI, I2C, 24 GPIOs
- **Other**
  - Compatible with SN2xx series
  - QFN48 and QFN40 packages available



STM32W Software libraries



ZigBee Modules Portfolio



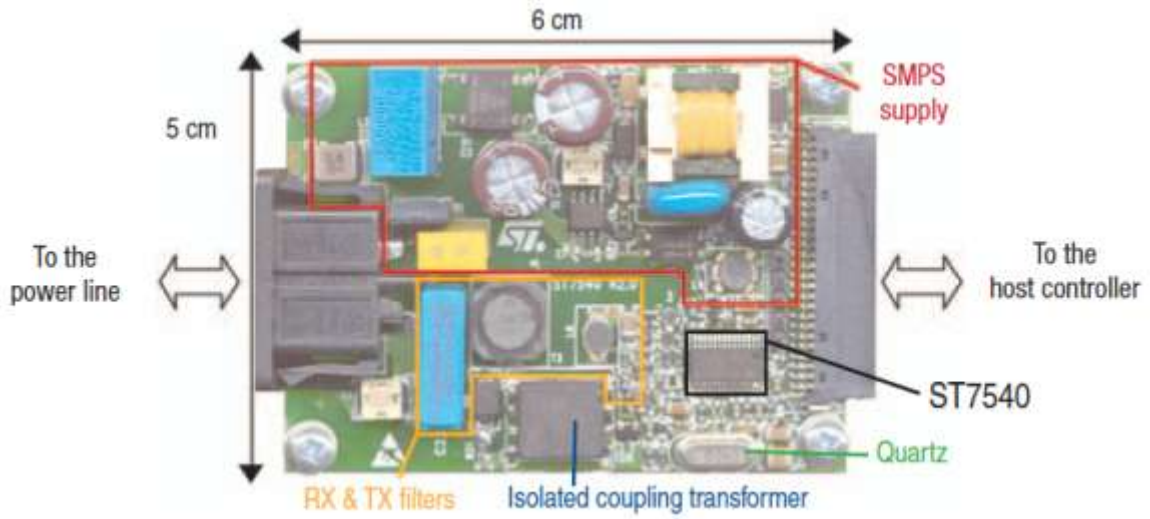
Mass Market Production

Sampling

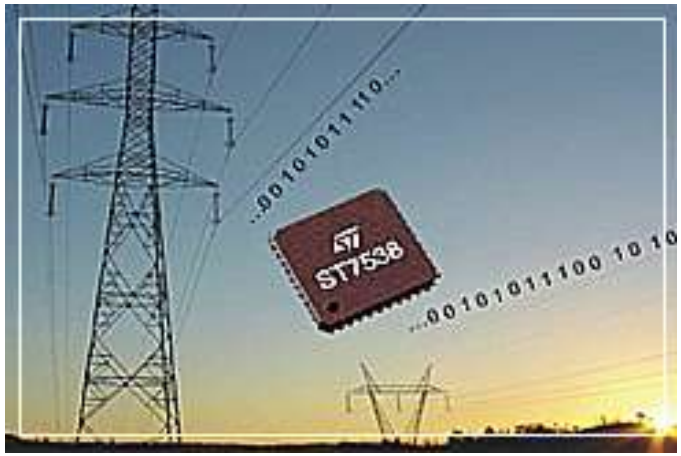
In development

Power Line Communication

Power Line Communication



Product	Description
ST7590	Narrow-band OFDM power line networking PRIME compliant system-on-chip
ST7580	FSK, N-PSK multi-mode power line networking system-on-chip
ST7570	S-FSK power line networking system-on-chip
ST7540	FSK power line transceiver
ST7538	FSK stripped down power line



Ideal for:

- Outdoor applications:
  - Remote Automatic Meter Reading (AMR) and bidirectional Automatic Meter Management (AMM) for Electricity, Water and Gas
  - Street and traffic lighting control
- Indoor Applications:
  - Home and building automation (Smart appliances networking, Room scenarios, Lighting fixture control, Security, Load management)